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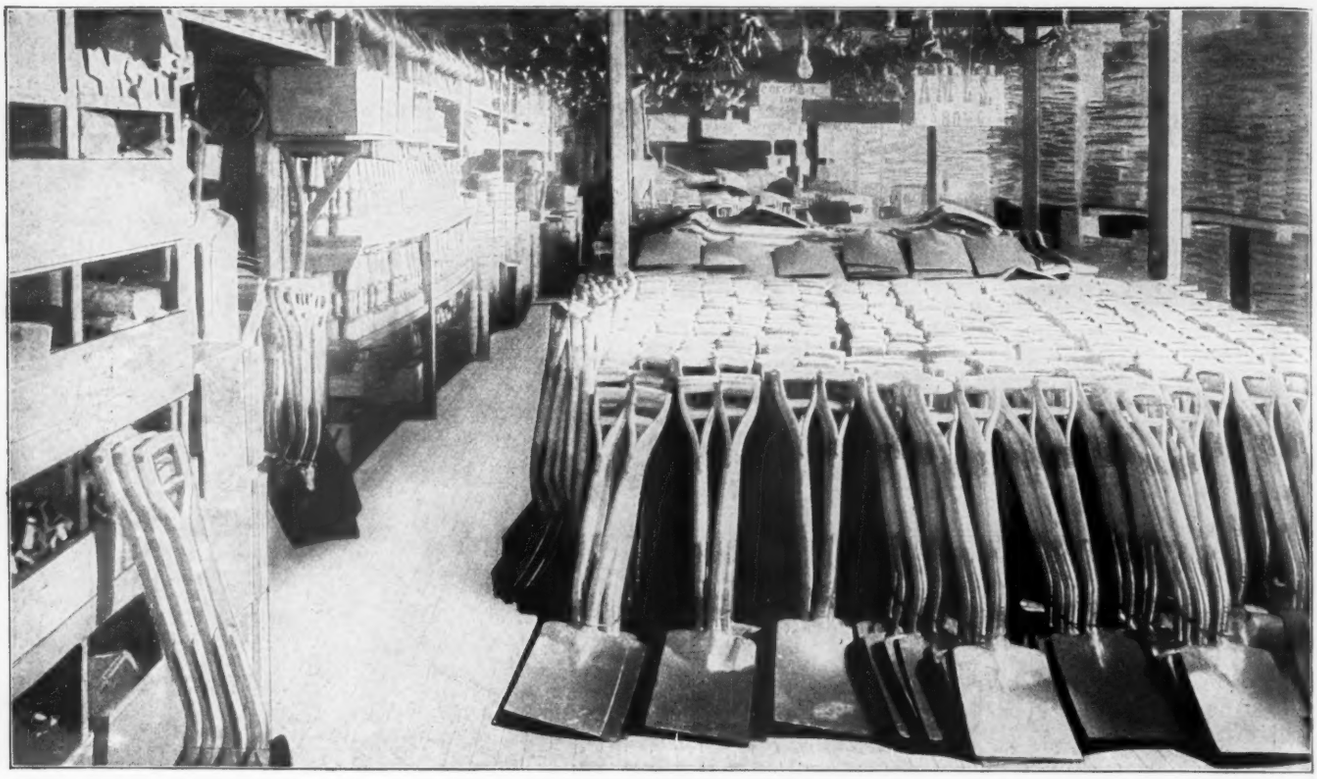

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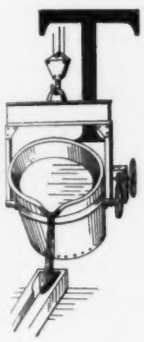
THE FOUNDRY

Vol. 35, No. 2 CLEVELAND, OHIO, OCTOBER, 1909 Whole No. 206

MOLDING LARGE GRAY IRON CASTINGS

Method of molding and casting 115-ton engine frames --- Problem of handling these large sections in the foundry and machine shop



THOUGH no claim is made that the 24 engine frames recently cast in the foundry of the Snow Steam Pump Works, Buffalo, established a new record for size and weight, yet, it is doubtful whether larger gray iron castings have heretofore been produced. The frames weighed close to 230,000 pounds each after being machined, and before the removal of the cores their weight was estimated at 350,000 pounds. The castings were made right and left hand for 12 twin-tandem, double-acting gas engines of 3,600 horsepower capacity each, built by the Snow works for the United States Steel Corporation for installation in the Duquesne and Youngstown plants of the Carnegie Steel Co. and the South Chicago plant of the Illinois Steel Co. Six of the engines were equipped with blowing tubs, while the remaining six were for power service. The blowing engines weighed nearly 2,000,000 pounds each, or 555 pounds per horsepower, while the power engines were about 300,000 pounds lighter, and averaged 472 pounds per horsepower.

Weights of Other Engine Parts.

Being water-jacketed almost throughout, all of the castings for these engines entailed an enormous amount of core work, while the fly-wheels, made in eight segments, weighed 180,000 pounds each. The hubs consisted of two circular castings, each half weighing 18,000 pounds. The cylinders, which were 43 inches in diameter with 60-inch stroke, were made of cast steel,

FIG. 1—DRAG HALF OF LARGE ENGINE FRAME MOLD, SHOWING PILLOW BLOCK SECTION IN THE FOREGROUND

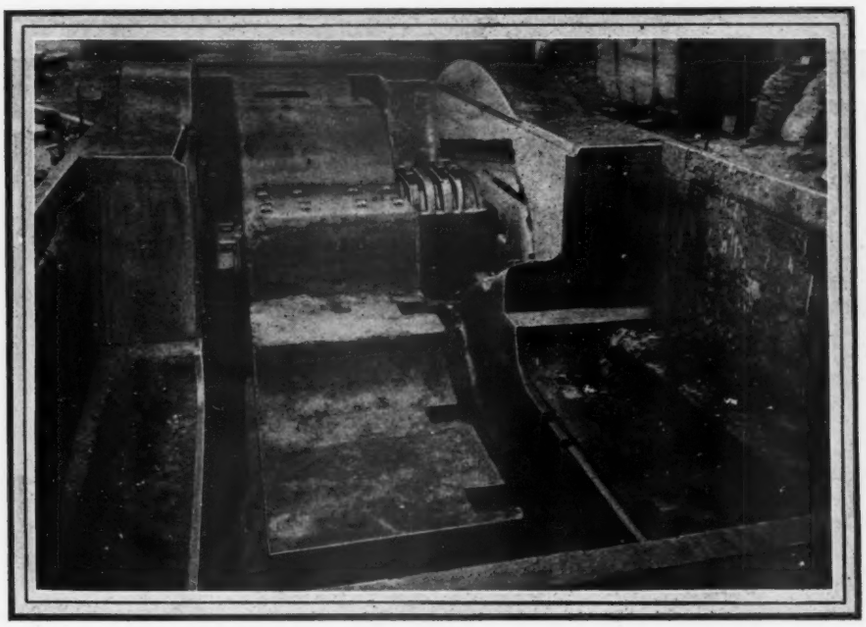


FIG. 2—DRAG HALF OF ENGINE FRAME MOLD. THIS VIEW WAS TAKEN FROM THE OPPOSITE END TO THAT SHOWN IN FIG. 1

in two sections, held together with links shrunk in place, and were provided with cast iron liners. Each half of the cylinder weighed 29,000 pounds, while the cast steel cranks, two on each shaft, weighed 25,900 pounds each. The weight of each crank shaft was 50 tons, and the main crossheads weighed 10,600 pounds.

Owing to the limited crane capacity of the foundry, the handling of these large engine frames presented a difficult problem, but the fact that none of these sections was lost, and the casting record averaged three a month while the order was going through the shop, indicates that all obstacles were successfully overcome.

The frames were molded and cast in four pits, two 40 feet long and two 37 feet long, each being 17 feet wide and 10 feet deep. The walls in the bottoms of these pits consist of cast iron plates, those forming the bottoms being 2½ inches thick and the side plates, 1¾ inches thick, are flanged on their upper edges with openings spaced 12 inches apart through which bolts are passed for binding the molds. As all of the pits extend several feet below water level, drains are provided for each, sunk two feet lower than the bottoms of the pits. These drains also serve as excellent vents for these large molds, as the gases rise out of the manholes in large volume when one of these frames is being cast.

As these frames were all of the box type of construction, they were cored almost throughout, and owing to their design none of the cores could be hung in the cope. This necessitated the use of no less than 96 dry sand cores, and for supporting them in the mold approximately 250 chaplets were required. The fact that none of these frames showed any defects as a result of the use of such a large number of chaplets, is satisfactory evidence that many of the difficulties arising from the use of chaplets must be charged to carelessness, unsatisfactory tinning, etc. To strengthen the large cores, cast iron anchors or spiders were used, which were broken up when the cores were dug out of the castings. The small openings in these frames prevented the use of wrought iron bars. The frames varied in thickness from 2 to 2½ inches, the pillow block ends being heaviest in section.

Patterns.

Only two patterns were required for the frames for both the power and blowing engines, as the change pieces of the patterns permitted of the molding of either the right or left hand frames by transferring these loose parts from one side of the frame to the other. The pattern for a blowing engine frame in one of the pits, not entirely assembled, is shown in Fig. 3.

Before placing the pattern in the pit, the bottom was covered with a bed of cinders to insure a free vent for the escape of the gases, and this was covered with a layer of sand, rammed hard to insure a level bed for the pattern.

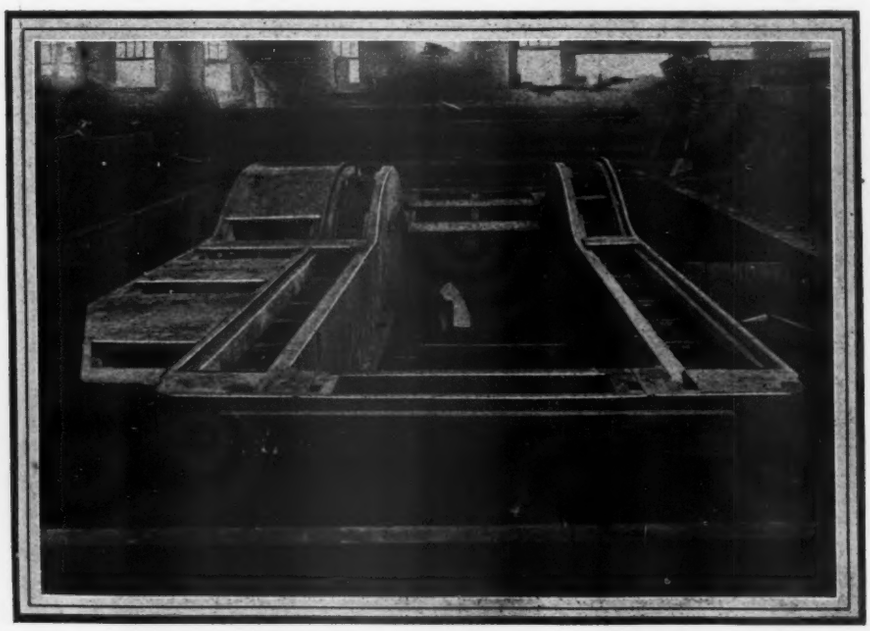


FIG. 3—PATTERN FOR BLOWING ENGINE FRAME IN ONE OF THE PITS NOT ENTIRELY ASSEMBLED

Molding the Frames.

The design of these frames complicated the problem of molding considerably, and it was necessary to ram the large crosshead guide core in green sand in the drag. To permit of the removal of this core, shown in Fig. 4, the drawback, Fig. 5, had to be provided for, and this was lifted out before the pattern could be taken out of the sand. This core was rammed on a large anchor, through which steel bars were extended for attaching the crane hooks. The drawback was made in a U-shaped flask, flanged and barred. The core and drawback were skin dried while out of the drag, and before the cores were set in place, the drag half of the mold was dried with

charcoal fires. A view of the drag with the pillow block end in the foreground, is shown in Fig. 1, and a view from the opposite end of the mold is illustrated in Fig. 2. Fig. 6 shows the drag with the cores in place taken from the pillow block end, while the opposite end of the mold at this stage of its construction with gates at each corner, is illustrated in Fig. 8.

The Cope.

The cope half of the mold was made in three sections, the flask directly over the drag being in two parts, and that section of the cope over the pillow block was left open, the remainder of this part of the mold being carried in another flask, set upon the pillow block section of the cope, and contained the remainder of the cope half of the mold that formed the bottom of the pillow block. These flasks each had a depth of 15 inches, and as the pillow block extended 18 inches below the drag, this arrangement became necessary. The flask set upon the cope and extending slightly more than half its length, is clearly shown in Fig. 7, which also illustrates the method of binding with cast iron beams extending across the top of the mold, tied down with bolts held in the flanges on the upper edges of the side plates of the pit.

Owing to the width of the mold and to prevent possible straining, it was heavily weighted in the center. A runner box with two gates each, was placed at either end of the mold, as shown in Fig. 7, and two additional runner boxes were provided to insure a steady flow of metal from the ladles. The iron was carried to the bottom of the mold by the gates, and eight risers, 4 inches in diameter, each extending 18 inches above the cope, were also used and were fed with small ladles, being constantly stirred.

Pouring the Casting.

While pouring the casting, two ladles were used, and when the smaller one was emptied the set ladle was used, so that the runner boxes were constantly kept full of metal. When the other ladle was emptied a fourth ladle was brought up, and by this arrangement two ladles were always in use until the casting operation was finished. As the melting equipment of the foundry is limited to two cupolas, lined to 54 and 68 inches respectively, the iron, approximately 120 tons, had to be held about three hours. To prevent the loss of heat, the metal was liberally covered with charcoal and there was no noticeable reduction in the temperature. The casting was permitted to remain in the sand about a week before lifting off the cope. Only the large center cores could be dug out in the pit, while the smaller cores were removed on the charging floor. With four pits in use, three frames were cast in four weeks, and this record was maintained until the order was filled. About one week was required for molding and during the second week the cores were set in place.

FIG. 4—LARGE CROSSHEAD GUIDE CORE MADE IN GREEN SAND

As the foundry is equipped with only three cranes, two of 30 tons and one of 20 tons capacity, the handling of these frames presented a difficult problem. After the surplus sand was removed from the pit and the large center cores taken out, the frames were blocked up, first one end then the other, the casting being lifted at either end by two cranes. When on a level with the top of the pit an equalizer beam was attached at one end, as shown in Fig. 9, and another beam with one end resting on the casting was attached at the opposite end. By the use of the three cranes, the casting was skidded onto plates resting on heavy rollers, which operated on a track 8 feet wide, laid in the foundry

FIG. 5—THE DRAWBACK NECESSARY TO PERMIT OF THE REMOVAL OF THE GREEN SAND CORE AND THE PATTERN

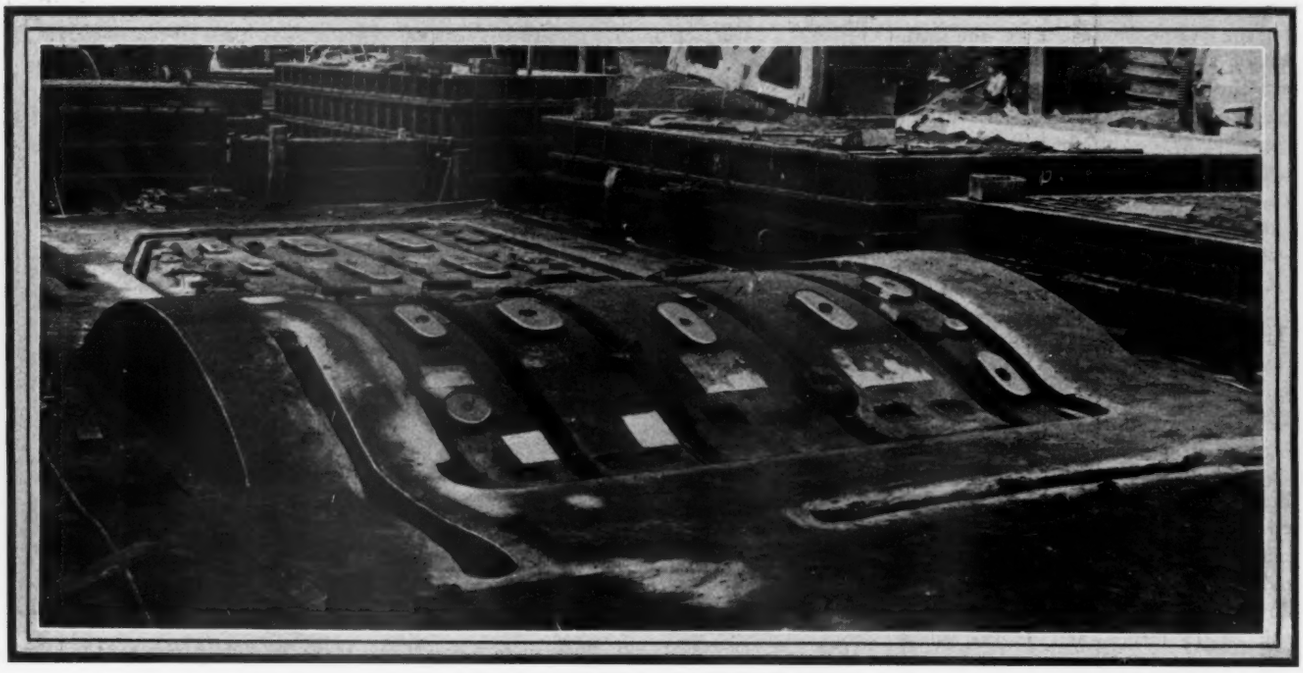


FIG. 6—DRAG HALF OF THE MOLD WITH CORES IN PLACE. THE PILLOW BLOCK END IS IN THE FOREGROUND

to facilitate the handling of these frames. After being cleaned the castings were conveyed to the machine shop, and as the crane facilities in this department were inadequate, the machine tools were brought up to the frames, to perform the finishing operations. From the machine shop the castings were taken into the yard, and by means of a motor-driven windlass were hauled over a wide track on rollers, loaded onto a flat car and conveyed to the erecting floor.

THE DISTRIBUTION OF FOUNDRY TONNAGE BURDENS.

BY VICTOR R. CLAYDON

There apparently is a diversity of opinion as to the correct method of distributing the foundry tonnage burden in

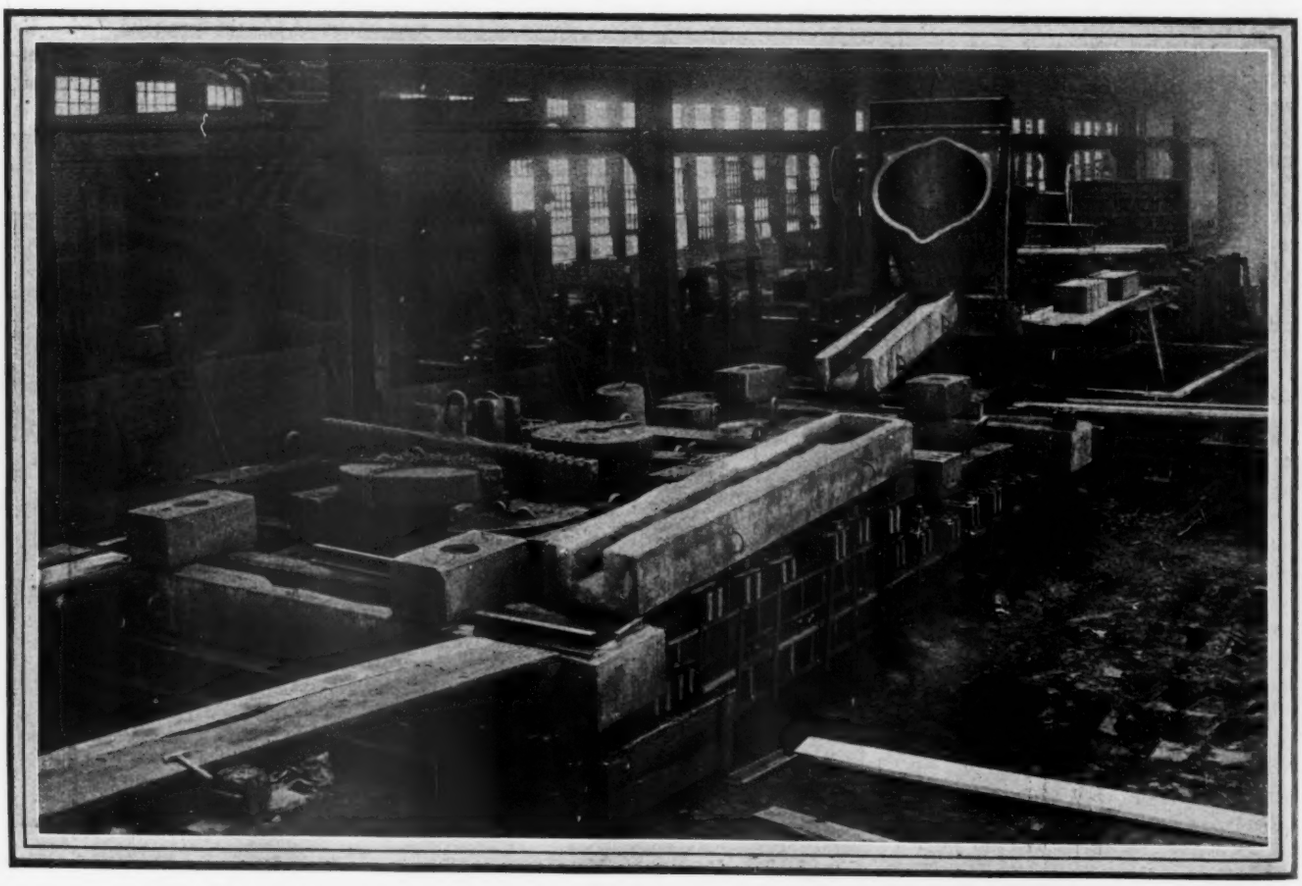


FIG. 7—LARGE ENGINE FRAME MOLD READY FOR CASTING SHOWING THE RUNNER BOXES IN PLACE

FIG. 8—OPPOSITE END OF DRAG HALF OF THE MOLD, SHOWING CORES IN PLACE

a business where the costs are based on the different classes of castings produced; and it is the purpose of this article to deal with the two main opinions that have been expressed in the course of inquiry on the subject:

1.—That the whole of the tonnage burden should be distributed on the basis of good castings *only* of each class produced.

2.—That the whole of the tonnage burden should be distributed on the basis of good and bad castings of each class produced.

For the purposes of illustration we will assume that we are in a business where the costs are divided into three distinct classes of manufacture, viz: boilers, steam fittings, and jobbing, and that the following are the production

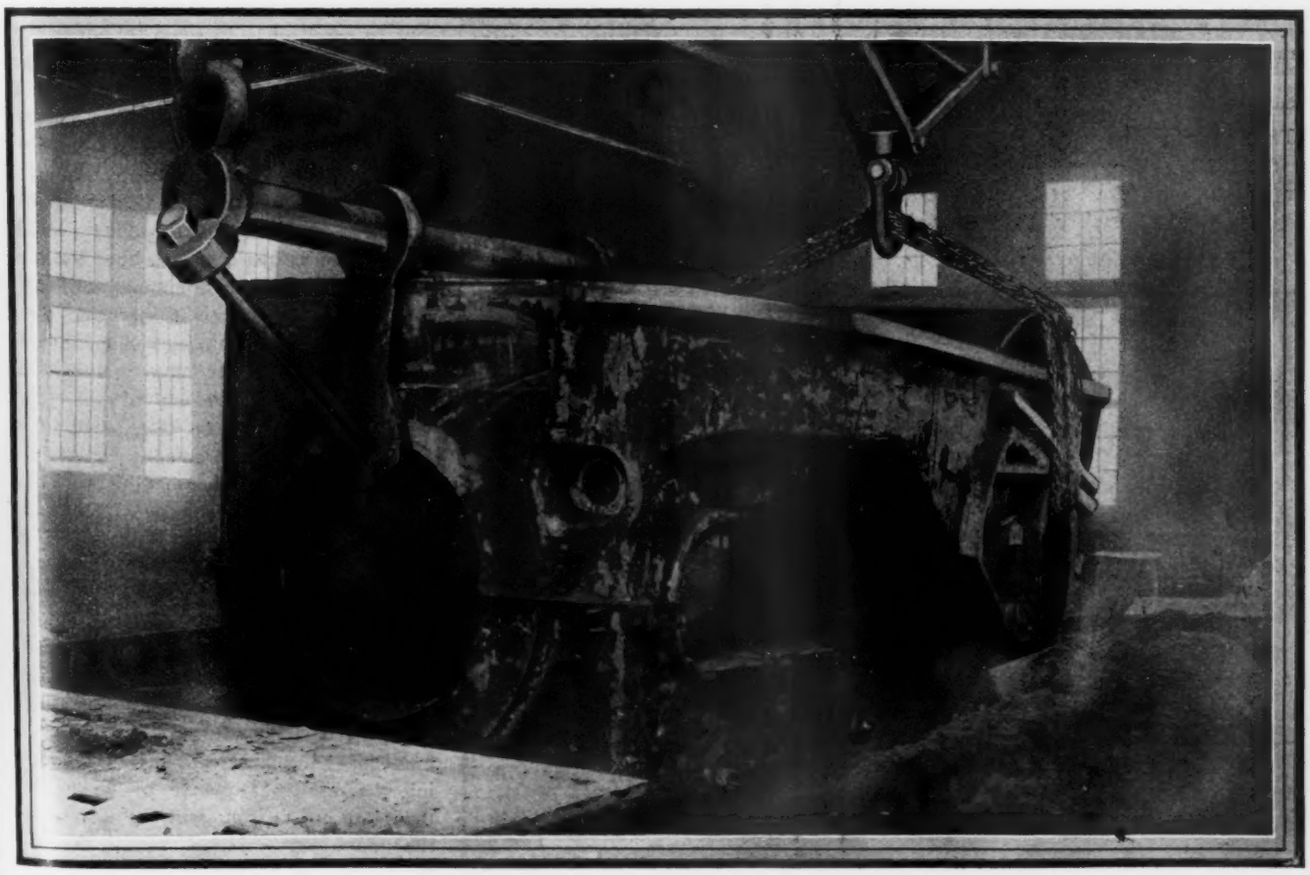


FIG. 9—LIFTING ONE OF THE LARGE FRAMES OUT OF THE MOLDING PIT

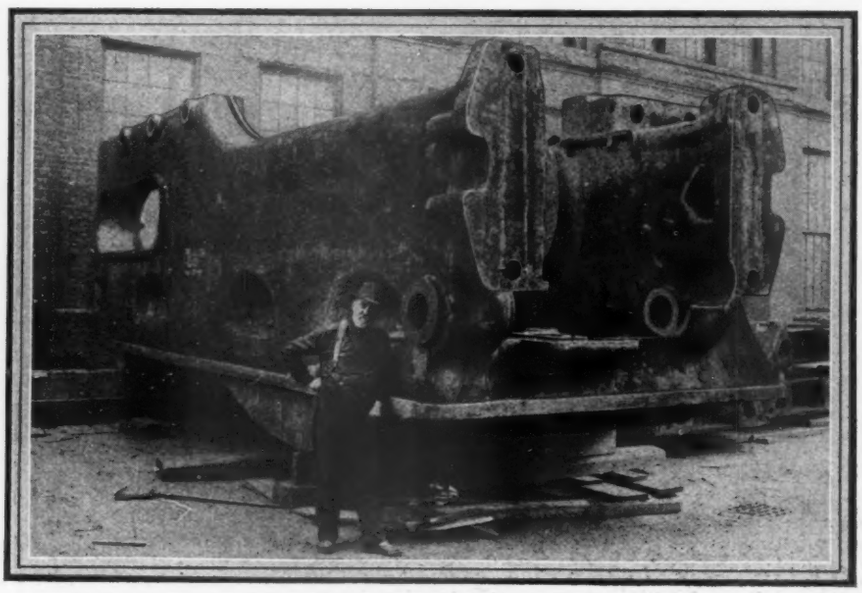


FIG. 10—ONE OF THE LARGE BLOWING ENGINE FRAMES

reports sent in to the cost office for a fortnight's cast:

(A) APPORTIONMENT OF TOTAL MELT.

	Pounds.
Good castings produced, all classes...	443,585
Bad castings produced, all classes....	56,260
Sprues and gates	194,595
Shrinkage	27,080
Total melt	721,520

(B) DISTRIBUTION OF GOOD CASTINGS.

Boilers	370,951
Steam fittings	45,182
Jobbing	27,452
Total good castings	443 585

(C) DISTRIBUTION OF BAD CASTINGS.

Boilers	44 294
Steam fittings	7 550
Jobbing	4,416
Total bad castings	56,260

The tonnage burden on the cast is $1,416.09. We will now divide our costs on the basis of good castings only, of each class produced:

(D) DISTRIBUTION OF TONNAGE BURDEN ON GOOD CASTINGS ONLY.

Class	Pounds	Per Cent of total good castings	Distribution of tonnage burden
Boilers	370,951	83.63	$1,184.28
Steam fittings.	45,182	10.18	144.16
Jobbing	27,452	6.19	87.65
Total good castings	443,585		$1,416.09

By dividing our costs on the basis of good and bad castings produced, we get the following results:

(E) DISTRIBUTION OF TONNAGE BURDEN ON GOOD AND BAD CASTINGS.

Class (Add B & C)	Pounds	Per Cent of total good & bad castings	Distribution of tonnage burden
Boilers	415,245	83.07	$1,176.35
Steam fittings.	52,732	10.54	149.25
Jobbing	31,868	6.39	90.49
Total good and bad castings	499,845		$1.416.09

It is of course, self-evident, that to obtain the cost of the tonnage burden per pound of good castings of any class, we must divide by the good castings *only* of that class, *after* the correct distribution of the costs has been made. The whole purpose of this paper is to try and determine whether table D or E is the correct method of distribution.

Assuming that the distribution according to Table D is correct, then it appears to me that the branch of the business which is actually losing the most work, is producing the cheapest castings; which on the face of it seems absurd.

In Table E we have the foundry tonnage charge spread over the different classes of castings produced, on a basis of good and bad castings. Although, in the examples given, the percentages do not differ very materially, yet I think they will serve to bring out the point that in distributing the burden on this basis the onus is put on the branch of the business which is losing the most work, and this would seem to be the correct apportionment.

It has been pointed out to me in course of correspondence on this subject, that one cannot consider bad castings as "output". Whilst admitting this fact, it is surely no less a fact that the production of a certain proportion of them is inevitable in the production of output, and consequently it seems only logical that each class should be burdened with its own proportion of this unmarketable product.

There is just one other point I would like to touch on: In some foundries the item of cleaning and chipping has to be taken as a tonnage burden. In such a case I venture to think that this portion of the tonnage burden should be distributed on good castings only, and for the following reasons: Most of the defective work, in all probability, would be detected before reaching the cleaning shop, and if such is the case, and only an insignificant fraction of bad castings finds its way into this shop, then I suggest this is the correct method. In short, any given element of the tonnage burden should be distributed *only* over the tonnage actually receiving the expenditure corresponding to that element.—*The Engineering Magazine.*

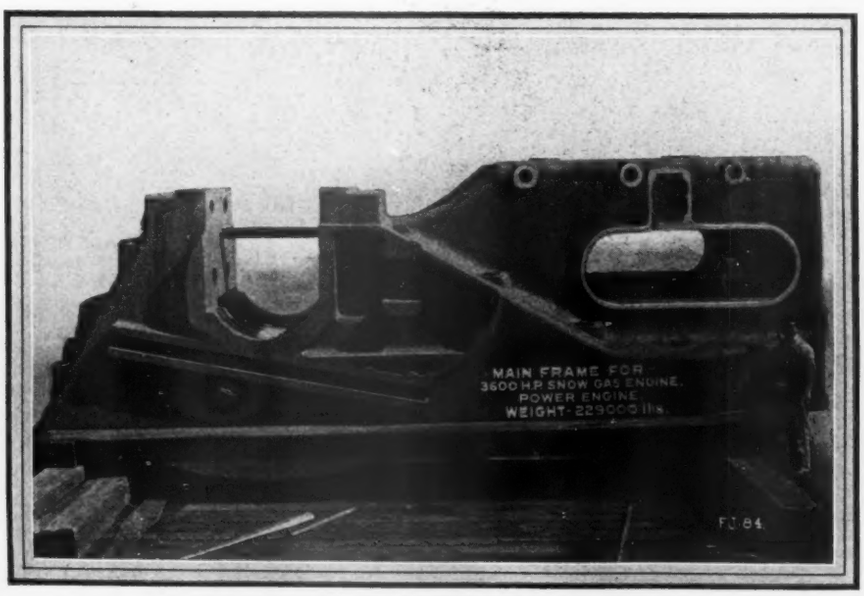


FIG. 11—ONE OF THE LARGE POWER ENGINE FRAMES

TECHNICAL TRAINING IN FOUNDRY WORK.

The efforts of the British Foundrymen's Association to stimulate the interest of foundrymen in a scientific study of their work has received recognition from the Birmingham (Eng.) municipal technical authorities. During the winter, a course of eight lectures on cast iron will be given at the municipal technical school, by A. H. Hiorns, in charge of the metallurgical department of this institution.

ENAMELED CAST IRON SANITARY WARE--V

General arrangement of a modern, machine-molding foundry for the production of bath tubs--- Advantages and disadvantages of the continuous pouring system

BY DILLEN UNDERHILL

IN THE manufacture of bath tubs, two methods have been followed, namely, the continuous pouring system and the ordinary method of pouring after all of the molds have been rammed. Each system has its loyal advocates, who have many good reasons why the other method should not be adopted. A plan view of a bath tub foundry in which the molds are poured at the end of the day, is shown in Fig. 1. This is illustrated, not because this method is favored more than the continuous system, but because both systems can be explained by one plan.

Foundry Layout.

The foundry shown has a capacity of 250 tubs per day of 10 hours. This is on the basis of an average output of 25 to 28 tubs for each complete molding machine, as described in the September number of THE FOUNDRY. No attempt has been made to show the shop construction, and the floor plans have been combined, which are more clearly illustrated in the sectional view, Fig. 2. As to dimensions governing the amount of space allowed for machines and molds, these can be estimated relatively by the distance from center to center of the crane runway XX, which is 40 feet, while the over all length of the foundry is about 400 feet. The length of the shop is variable, depending upon the amount of storage required for the various sizes of machines that are used. It is the usual practice to keep all, or practically all of the various sizes of flasks and molding machines in the ends of the building instead of storing them, as is generally done, in the pattern storage building.

Stored in the ends of the shop they can be placed on the molding machine floor without delay. The cope, cheek and drag flasks are separately stacked, that is, the drags upon drags, etc., so as to economize space as much as possible.

Referring to Fig. 1, it will be noted that two shaking-out machines are located in the middle of the plant. These are almost entirely below the floor level, and on each a flask is placed after being poured. At the sides of each machine are bars, YY, Fig. 2, to which are connected at each end, vertical, pivoted plungers and whose lower ends are provided with rollers resting on cams. After the mold has been poured it is placed on the bars YY, the clamps are knocked off and the mold is separated, the casting removed, the cope and cheek-halves of the flask remaining in the shaking-out machine, the cams are thrown in gear and start to revolve and these in turn move the plunger up and in turn permit it to drop; the cams on the other side then come into action as soon as the first cam ceases operation, so that first one end and then the other end of the cope and drag flasks are alternately raised about four inches and dropped. This operation leaves very little sand adhering to the flask unless the sand piles up in a heap on the grating, and in this case the sand in the flask is jarred loose with a billet of wood. The mold is placed on these bars by the crane and then the crane hooks are removed from the drag flask, the chain hooks being dropped into the holes in the cheek flask and the mold is separated in this way. The tub casting usually sticks in the cheek and must be pried down with a bar, as the pouring gates run from the rim and up through both cheek and cope, having a tendency to hold up the tub. When the tub is rolled off the drag onto the floor between the two shaking-out machines at Z, the runners and gates are broken off and these, and other small pieces are thrown into a wheelbarrow and the tub is taken to the storage or the cleaning room.

It is advisable to store the tubs with the sand still adhering to the sides as this resists rust for a considerable length of time. The enamel will not adhere to oxide of iron, so that if the tubs are badly rusted it is necessary to sand blast them a second time. The sand falls from the flasks onto a movable grating which is operated only so long as there is sand to be riddled. This grating is made of a series of bars about ¾-inch thick, and is provided with projecting lugs about ¾-inch long on either sides of the bars, spaced at regular intervals throughout their length. The bars are connected at the ends to cranks or arms, so that they operate in opposite directions to each other, similar to placing the fingers of the two hands together and then sliding them back and forth. This movement grinds the burnt sand, and at the same time prevents large pieces of iron, such as parts of the gates or runners, from falling onto the sand conveyor underneath. To maintain the sand at the required standard strength and consistency, new sand is dumped upon the grating at regular intervals and is mixed with the sand which is shaken out of the flasks.

Sand Conveyors.

For the sand conveyor machinery, a pit extending across the width of the foundry is provided in which a structural steel and cast iron frame is built, to which the grating and other operating mechanism are attached. Below the grating, and attached to the frame, is a cast iron or steel plate hopper for concentrating the sand on the conveyor belt. These hopper plates are bolted in place in sections, and in such a manner that they can be readily removed and replaced, inasmuch as the sand falling on them continuously, subjects them to considerable wear. The belt conveyors provided, one to each machine, deliver the sand to both sides of the foundry. As the sand falls through the grating onto the belt conveyor, it is tempered with water sprayed from a gas pipe, drilled with a series of holes throughout its length. The quantity of water required is measured by a tank in circuit with the regular water pipe. The tank is allowed to be alternately filled and emptied, a water gage being provided to indicate the amount of water in the tank. An

endless belt conveyor is located below the hopper which delivers the tempered sand to an elevator boot, from which it is carried in buckets above a gallery floor shown at VV. At this level the sand flows from the elevator spout into a revolving sieve or riddle, and is delivered into a long wood conveyor box and is then alternately carried toward each end of the foundry. Each elevator and the shaking out machinery are operated by a motor in the pit. The elevator is operated by a belt from the main shaft in the pit leading to the head shaft, while on account of the rapid cutting action of the pulverized sand, sprocket wheels, chains and cast gears are used for operating the shaking-out machinery. Ample room should be provided around this equipment so that repairs can be quickly made, as breakdowns usually occur when the tubs are being poured and the cupola is being tapped.

Sand Troughs.

After the sand has been riled it falls into the upper conveyors. These are long wood troughs, UU, about 2 feet wide, which extend along either side of the crane runways. The bottoms of the troughs are on about the same level as the crane rails, while on top the sides of the troughs, at regular intervals, are iron guides for holding rollers attached to the sand conveyors to prevent them from riding over the sand in its forward movement. The sand conveyors are made up of 4-inch gas pipe, to which are attached floating plates. They are so arranged that when they move toward the supply of sand they pass over the same, but when the motion is reversed, they assume a vertical position and push the sand ahead of them. These conveyors, which are not shown, are operated by connecting rods, tt, which in turn are geared back to motors S. This mechanism is located above the ground level, or in the gallery, and must be rigidly supported to well designed steel or brick-work. The quick reciprocating motion of these conveyors, together with the heavy blows of the floating

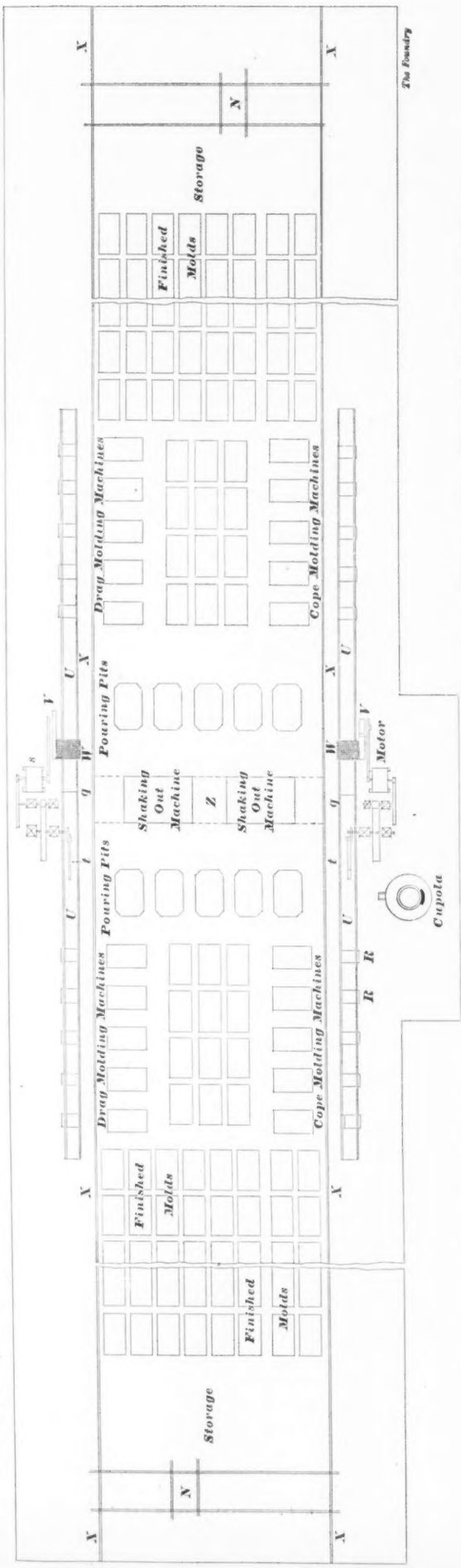


FIG. 1—PLAN OF BATH TUB FOUNDRY SHOWING ARRANGEMENT OF MOLDING MACHINES, POURING PITS AND SAND HANDLING MACHINERY

plates against the sand, produce an immense impact load, and unless this is properly cared for in the design, the runways will soon get out of line, and the wear and tear on the traveling cranes will result in an enormous amount of repairs.

Arrangement of Sand Delivery.

Near the ends of the conveyor troughs are shown openings, RR, through which the sand falls to the ground floor into bins close to the molding machines. The size of the openings in the conveyor troughs is regulated by a flat plate which acts as a gate, and which is drawn out when sand is required. If all the molding machines are in operation, the gates are pulled out approximately 3 inches for the one nearest the center of the foundry, 6 inches for the second, 9 inches for the third, etc. The ends of the troughs are left open, so that in case the bins fill up to the conveyor openings, the sand will not pack in the conveyor troughs but will overflow at the ends. After the sand reaches the elevator, V, it is delivered in the conveyor troughs at qq. At this point the floating blades reverse and over-travel the distance they are set apart, so that when the conveyor moves in one direction, one set of blades pushes the sand that falls into the trough in one direction, and when the reverse motion occurs the other blades carry the sand in the opposite direction.

Separate bins are provided for each cheek and drag machine. These are open at the bottom and in some cases are entirely open on the sides facing the machines. The latter arrangement, however, reduces the capacity of the bins, whereas when open only at the bottom the entire bin can be filled.

Cooling the Sand.

As the tubs are shaken out soon after the metal has set, the sand is at a high temperature when it passes down through the shaking-out machine. The tempering water coming in contact with the hot sand in the shaking-out machine reduces the temperature

somewhat, although the sand is still too hot to ram. The subsequent cooling must, therefore, take place for the most part in the trough conveyor, and for this reason it is made very wide, and the conveyor moves at such a rate as will permit the sand to cool before it reaches the foundry floor again. This feature is not so important if the molds are poured at the end of the day, but if a night shift is at work, or the foundry is operating on the continuous system, the sand must be permitted to cool in transit. No manual labor is required in the preparation of the sand other than wheeling new sand to the shaking-out pits. Thus

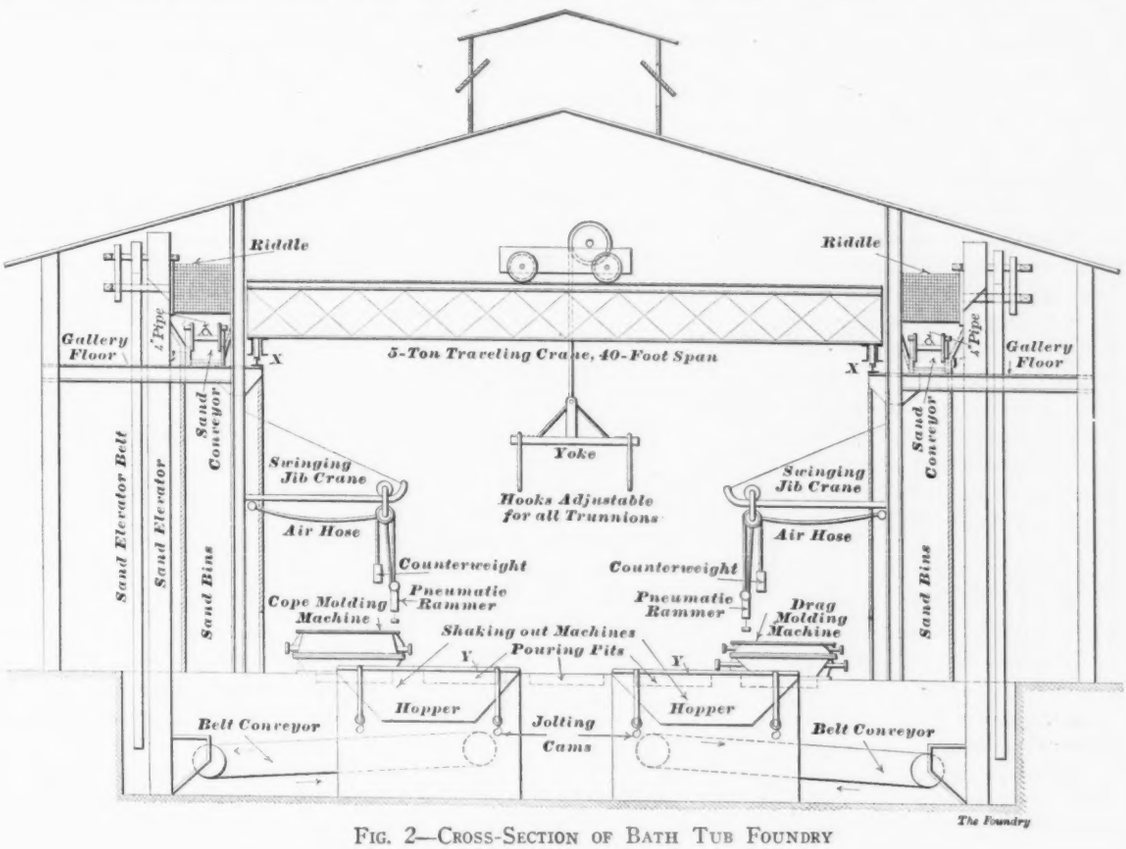


FIG. 2—CROSS-SECTION OF BATH TUB FOUNDRY

far no reference has been made to the disposal of the burnt sand. However, when the tubs are shaken out, a fairly thick crust of burnt sand adheres to the surface of the castings and new sand is added in quantities equal to the burnt sand lost in this way. No parting sand is used on the cast iron patterns for the tubs, nor is a hand riddle used before shoveling the backing sand into the molds. The sand, as it comes from the heap, is shoveled into the flask at once, and rammed.

Pouring Pits.

On either side of the shaking-out machines are shown five pouring pits. These are about 8 inches deep so that when the molds are placed in the pits they are not too high for the four men who do the pouring and to enable them to conveniently lift their ladles to the proper height. The sides of the pit are made up of channels riveted together and fit closely around the drag. The corners are also filled in so that the men who do the pouring cannot stumble when bringing up their ladles filled with molten iron. In the bottoms of the pits are placed cross rails on which the drags rest while the molds are being poured.

Pneumatic Rammers.

Close to, and below the crane runway, on either side, are shown the molding machines. The drag machines are placed on one side of the foundry and the cheek machines on the opposite side. Two men operate each machine, shoveling in the sand and ramming the molds. Pneumatic rammers are used, counterbalanced with sash cords running through a pulley and fastened to a weight. The pulley is attached to a light wrought iron bar swung as a jib crane, which gives a free movement within the range of the arm, and also permits the entire device to be swung back to the wall when placing on or taking off a flask.

A sectional view near the middle of the foundry and through the shaking-out pits, is shown in Fig. 2. The shaking out machines, together with the hoppers, jolting cams, and the belt conveyor are illustrated, but the grating through which the sand falls into the hopper is omitted. Its relative position as to height would be about the foundry floor level. The tempering pipes are set at the ends of each machine just below the grating, while the tank and the gage for measuring the amount of water required are usually fastened to a column. All levers for operating the shaking-out machines and other sand conveying machinery in the pit are located above the floor level and are arranged in a line with the columns. One motor at each end of the pit operates all of the machinery on either side of the center. Ordinary jaw clutches are used for starting and stopping the machinery. On each gallery floor motors are provided for operating the sand conveyors only. The elevator, however, is driven by a vertical belt running down into the pit, operating over a pulley on a jack shaft.

Construction of the Yoke.

Suspended from the crane is a yoke used for lifting the molding machines, as well as the cheek and drag molds, and which is also used for turning them over. As the trunnions must be of different lengths, the hooks are made to set in notches in the horizontal bar of the yoke, which is best made of channels or I-beams, preferably the

former, riveted together as shown. On top at the ends is riveted a flat iron bar bent back and forth into a number of serrations, similar to saw teeth, except that the bends are rounded and are a little larger than the diameter of the hooks. To the upper end of the hook is welded a loop to prevent the hook from slipping off. This arrangement provides a quick method of varying the length endwise. The cheek and drag flasks are provided with openings for attaching the chains, the latter being made with large rings in the center which are thrown over the hook on the yoke, and a hook in each end of the chain is dropped in the proper opening provided for it in the flask. For this reason the crane bridge should be set sufficiently high to accommodate this extra height, as the chains take up as much head room as the hooks. Therefore the crane rails should be set high and this in turn requires a high roof. This is a good feature, especially in a foundry operating on the continuous plan, and even when the best ventilating facilities are provided, the gases and smoke arising from the molds soon fill the entire shop. As it is rarely possible to secure proper ventilation in the sides of the building, the roof should be provided with a cupola extending the entire length, and should be sufficiently high to permit of the use of large swinging windows, similar to the ones shown.

Continuous System.

Up to this point, the arrangement of the machinery for the foundry operating continuously and the one pouring once daily is practically identical. When casting continuously, practically no molds are stored, and the copes and drags are closed in the space between the cope and drag machines and the molds are immediately taken to the pouring pits. The only additional space that must be provided for in a shop of this kind is that required for the storage of the molding machines not in immediate use. When casting only once daily, however, the molds are closed and stored as shown in the ground plan, Fig. 1, between the machines in each end of the foundry. The space at each end of the shop beneath the cranes, NN, is provided for the storage of patterns and machines.

The Cranes.

Two five-ton, 40-foot traveling cranes are used in handling the molds and molding machines. The mold, ready to pour, weighs about 2½ tons, but ample allowance must be made on account of the high speed at which the cranes are operated, and the fact that they are almost constantly in operation. The purchase of no equipment for a bath tub foundry should receive more careful consideration than the crane. The reason is clear, inasmuch as when the crane is down for repairs the shop must cease operations. As no spare machine can be utilized when an accident occurs to the crane, one entire floor is out of commission until the conveying machinery has been repaired. To overcome this difficulty, a double hoist has been suggested, one for each end of the crane, so constructed as to raise or lower two cranes simultaneously, that is, the one above the other. This would permit of the immediate use of a spare crane while the other is being repaired. As compressed air is used extensively in foundries of this type, it would seem that the details of construction could be easily worked out.

Sequence of Crane Operations.

The sequence of the crane operations, so that there will be no interruptions, is one of the problems that must be carefully considered in designing a plant of this kind. The cheek flask is first placed on the cheek molding machine, probably being brought from storage, and next the drag flask is conveyed to and placed on the drag machine, and these operations must be repeated for each of the 10 machines that the crane serves. In addition, the drag machines are lifted up, turned over and lifted away from the molds, and are then again turned back, placed in position for ramming and another drag flask is placed on the machine. The cheek half of the mold must next be lifted off the cheek machine and closed over the drag. After the flask has been clamped, it is taken to the pouring pit, or is stored for pouring later in the day. After the casting has been poured, the mold is shaken out on the shaking-out machine and the flasks are either taken to storage, or are placed on the molding machines to be used over again. In view of the large number of operations in which the crane plays a prominent part, it will readily be seen, that unless carried out in proper sequence, considerable delay will be incurred. When pouring continuously, requiring a still greater number of operations, it has been found that three cranes can be used to advantage, the middle crane operating on both sides of the center of the foundry.

Economy of Space.

Operating on the continuous system, a considerable saving of floor space can be effected, as practically no molds are stored and the size of the foundry can easily be reduced, 200 x 40 feet. The flask equipment can be reduced one-half, but owing to their more frequent use, the locating holes wear out rapidly. This is a serious objection to this system, as only a slight clearance can be allowed between the pins and locating holes. To illustrate, let us suppose that all of the locating holes have been worn 1/64 inch. There are two of these openings in the machines and the flasks each have corresponding locating holes which result in a possible shift of 1/64 inch. The tubs, ordinarily, are ¼-inch thick, and if this wear occurs in the locating holes, the tubs would be 3/16-inch thick on one side and 5/16-inch thick on the other. This is a common occurrence in bath tub foundries, and is frequently not detected until the castings reach the enameling ovens where, on account of the variations in thickness, they invariably crack. The loss is especially heavy if the tubs are not enameled the same day that they are cast and no opportunity is provided for detecting the difficulty until a number of tubs of uneven thickness have been made.

Repairs.

In foundries casting continuously, it is customary for the day gang to work 10 hours, six days in a week, while the night shift works 12 hours, five nights in the week. Only one hour, morning and evening is, therefore, allowed for making repairs. This is a vital point, as at best, frequently only temporary repairs can be made, and the cost for replacements of parts of equipment in a continuous pouring plant is high.

Few machines can be operated continuously day after day, and when driven in this way, unless properly relayed, they must finally be replaced by a duplicate machine. Good practice dictates that spare engines or dynamos be held in reserve in power plants and duplicate parts are carried in stock. In this way a complete shutdown is avoided and repairs can be quickly made. In a continuous foundry one operation is so much dependent on the other, that when an accident occurs, at least one-half of the foundry is idle. If this period of idleness is only one hour it means the loss of at least 12 tubs, which could have been made in that time. With the continuous system, the shaking-out machines, conveyors and sand machinery are almost constantly in operation. However, when casting only at the end of the day this equipment is operated only while the metal is being poured.

In the plan view, additional space is

shown at the sides of the crane runway which is used for molding feet, brackets and other small pieces that may be crowded out of the small-ware foundry. The cupola is shown on the side at the middle of the foundry conveniently located in relation to the pouring pits, and a railroad siding should also be laid so that coke, limestone and pig iron can be readily unloaded onto the charging floor. If a still larger foundry is desired, a duplicate of the shop shown in Fig. 1 can be built alongside. A center aisle should be left for wheeling out the castings, while parts of the sand-handling equipment located in the center can, to a certain extent, be combined. One motor can be arranged to do the work of two if desired, and the cupola may be set at the end of the foundry, and the hot metal sent forward to serve all of the pouring floors by building a tramway in the aisles between the two foundries.

Crane Construction.

Perhaps more difficulty is experienced in foundries of this type from the unsatisfactory operation of the cranes than from any other cause. A light lattice construction is recommended for the bridge, but it should be so designed as to insure absolute rigidity, and ample allowance must be made for carrying the loads. The light construction decreases the floating distance and enables the operator to reverse his crane quickly because of less momentum. All gears should be covered to protect them from the grinding action of the sand, but this covering should be easily removable and in some cases the entire carriage is covered with a light wood box.

The working force required for operating a bath tub foundry using molding machines, should consist of a foreman or superintendent and an assistant foreman; two men for each of the cheek and drag machines; a crane man, two laborers who follow the crane and eight men for carrying the metal from the cupola and pouring the molds. If casting only once daily, the metal can be handled by the molders. Two or more men should also be provided for wheeling out castings and scrap, the number depending upon the distance to the cleaning house or storage, and the usual cupola men and laborers for handling the pig iron, coke, etc., on the charging floor should also be employed.

INFLUENCE OF FORM AND POSITION ON CAST STEEL, TENSILE TEST BARS

BY R. A. BULL

ONE often acquires knowledge by unpleasant experience. The writer will preface his remarks on this subject by confessing that a large part of his own information concerning this topic owes its origin to his commission of what proved to be a metallurgical error several years ago, and a series of investigations he made subsequent thereto, concerning all of which a summary may be interesting to other steel founders.

Table I.

ROUND BAR CAST VERTICALLY.

Description.	Carbon, per cent.	Phosphorus, per cent.	Sulphur, per cent.	Manganese, per cent.	Silicon, per cent.
Turnings from skin	0.15	0.023	0.045	0.84	0.43
Borings from center	0.21	0.023	0.024	0.95	0.42

At the time the error referred to was made, it was necessary to submit daily a large number of bars for physical test. The steel castings which they represented were of such nature that it was not practicable, and not required, that the test coupons be attached to the castings, and they were cast separately. The expense of so casting them and afterwards machining them to the required half-inch diameter, for such a large number of tests per day, was great enough to warrant experimenting with the production of a cheaper bar. Previous to this time the standard bar in this foundry was made as shown in Fig. 1, in the form of a strip 1¼ inches thick, 1¾ inches deep, on the bottom of a plate 3 inches thick, of suitable length and width, the block and strip being cast horizontally and the latter being drilled off before going to the lathe.

The writer designed a round bar, in the form of an inverted "goose-neck," 1½ inches diameter, one leg being the gate, the other serving as vent and sink-head, the upper portion of each being increased in diameter approaching the top, the whole being cast vertically. It was very inexpensive to nick and break off the necessary length of one leg to provide a test bar, and the time required to turn in the lathe was materially reduced. The portion of the column selected for the bar was immediately above the connecting radius, as being the most likely to contain homogeneous metal. The mold thus described is shown in Fig. 2.

The result was pronouncedly disastrous. The engineer of tests whose duty it was to pass judgment on the material, very promptly and very properly rejected all castings made from a number of heats, which had meanwhile been shipped before the bars were pulled and conditionally accepted because of unavoidable delay in making the tensile tests. He was justified in this action because the bars suddenly dropped to about 50,000 pounds tensile strength, 8 per cent elongation, and 11 per cent reduction, previously unknown figures in this particular plant. And all this without any change in the melting stock, the furnace manipulation, or the chemical analysis of the finished product.

Segregation.

The writer examined the fractured bars, and the remaining stubs of the rough bars, and noticed pronounced piping in the upper portions of the latter, and in some cases, faint evidences of the same defect in the former. Segregation was suspected and found to be a certainty by comparing analyses taken from the skin and the

Table II.

Form of test rib.	Elastic limit per square inch.	Tensile strength, pounds per square inch.	Elastic ratio, per cent.	Elongation, per cent in 2 inches.	Reduction of area, per cent.
Round, vertical	34,340	49,615	69.21	7.4	11.3
Rectangular, horizontal.	50,650	72,718	69.65	21.8	33.8
Per cent efficiency of round rib compared with rectangular..	67.79	68.23	99.37	33.94	33.43

core of the rough bars. The analysis of one such shown in Table I is typical of all.

It is needless to say that we resorted at once to the old standard test block, the results becoming normal immediately, and perfectly satisfactory to the engineer of tests, to convince whom, however, that the fault lay in the characteristics of the bar itself and not in the metal of the previously rejected castings, sections were cut from these with considerable difficulty and expense. These sections, when turned to proper size and tested, averaged well above the specifications, although the castings were of basic steel, formed in green sand molds, not skin-dried, and consequently not expected to be perfectly homogeneous.

Some time after the facts noted were learned, it was suggested that the form of the test rib proper, attached beneath what we may term the feeding block of the horizontal test mold, be made in cylindrical form, to connect with the upper portion by a neck along its entire length. The idea in this case, as in the instance of the round vertical bar, was to reduce the expense of making the finished test piece, and is illustrated in Fig. 3.

Theoretically, it appeared that test bars made in this way would be inferior to those cast as shown in Fig. 1, for in the case of the rectangular rib, the metal in the same should have unexcelled opportunity for feeding from the heavy slab above, which would, it seemed, also tend to produce fluid-compression of the rib. With the bulb-shaped rib, it was thought that the neck attaching it to the feeding block would freeze before the heart of the cylinder solidified, and that because of this, the rib proper would not be of such high density as the rectangular rib. It was apparent that the bar could be broken off the slab without the expense of drilling or sawing, and this saving justified a trial, which, to be a true comparison, was made by testing 28 bars, made from 14 blocks, each block having one rectangular rib as shown in Fig. 1, and one cylindrical rib as illustrated in Fig. 3. All were poured in dry sand molds.

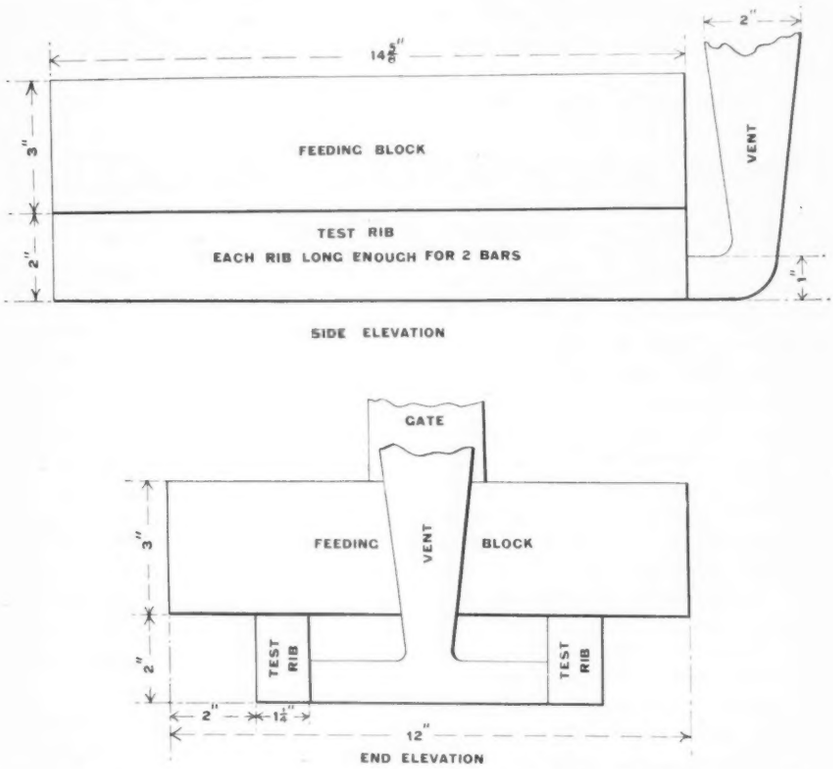


FIG. 1—CAST STEEL TEST BAR MOLD, SHOWING ARRANGEMENT OF GATE, FEEDING BLOCK AND VENT

Comparison of Tests.

Realizing that a comparison of tests made from the round vertical bars and the rectangular horizontal bars would be interesting and serve to further convince the purchaser that his castings were of good material, we then cast some 30 bars, half of each kind, pouring the old style test mold immediately after the new style, now discarded save for experiment. These were all cast in dry sand molds, and the metal was teemed when the ladle was half empty. Table II shows the result, in averages computed from all.

The results were surprising, as indicated in Table III, averages of all being shown.

It was difficult to understand the reason for the improvement in the elongation and reduction, especially the latter, in the cylindrical ribs. On careful reflection it seemed that in the case of the rectangular rib, which was connected to the heavy plate above without necking, and consequently by 66 2/3 per cent greater area, the capillary attraction of the mass above proved a greater force on the rib below than did gravitation, counteracting the feeding action. Obviously, if this were true, a reduction of the mass in the upper plate would improve the homogeneity of the test rib proper if made as shown in Fig. 1. And clearly, also, this being so, the specific gravity of the rectangular bars recorded in Table III would be lower than that found as representing the bulb-shaped bars. Specimens cut from undistorted sections of six of the ruptured bars of each type were tested for specific gravity, and it was found that the theory as to the superior density of the round ribs was in error, for the average specific gravity of the bars made from rectangular shape proved to be 7.848 (489.4 pounds per cubic foot, 0.28322 pounds per cubic inch), while that of the test pieces machined from cylindrical strips was 7.846 (489.27 pounds per cubic foot, 0.28314 pounds per cubic inch).

Table III.

Form of test rib.	Elastic limit per square inch.	Tensile strength, pounds per square inch.	Elastic ratio, per cent.	Elongation, per cent in 2 inches.	Reduction of area, per cent.
Rectangular.	35,157	66,314	53.02	29.4	39.7
Cylindrical..	34,857	66,414	52.48	30.6	46.8
Per cent efficiency of cylindrical rib as compared with rectangular rib	99.15	100.15	98.98	104.08	117.88

Table IV.

Form of test rib.	Elastic limit per square inch.	Tensile strength, pounds per square inch.	Elastic ratio, per cent.	Elongation, per cent in 2 inches.	Reduction of area, per cent.
3 inches thick	39,900	63,666	63	27	33.5
1 inch thick...	40,483	65,083	60.3	23	26.5
Per cent efficiency of 3-inch block as compared with 1-inch block.....	98.5	97.8	104.4	117.4	130.2

New test molds were made to throw additional light on the subject. These were identical in design with those shown in Fig. 3, as to the test strips themselves, but the upper plate was reduced to 1 inch thickness. Twelve

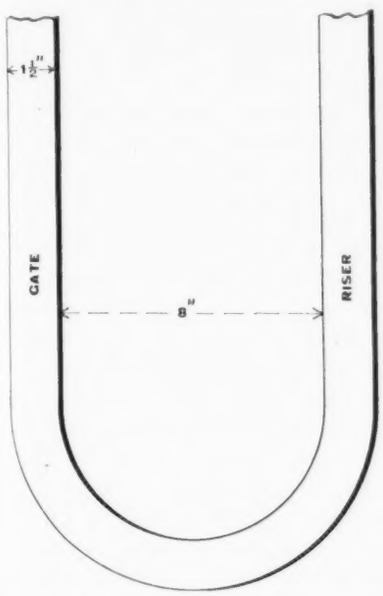


FIG. 2—MOLD FOR A U-SHAPED TEST BAR

test blocks were poured in six heats, all having cylindrical strips, one of the standard size 3-inch plate being poured immediately after casting the new 1-inch plate, in each of these heats. The average results of these bars are recorded in Table IV.

A striking fact should be stated concerning the averages shown in Table II. While there was no unexpected variation in the individual results of the bars made from the heavier slabs, and the elastic limit and tensile strength of the bars turned from the thin slabs remained practically constant, there was a great variation in

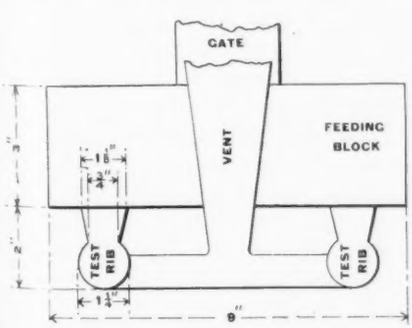


FIG. 3—IMPROVED METHOD OF MOLDING AND CASTING TEST BAR

the elongation and reduction of the latter, the range in elongation being from 12 per cent to 31 per cent, as compared with a divergence of 21 per cent to 30 per cent in the bars from the 3-inch blocks, and the range in reduction of area being from 16 per cent to 34 per cent, whereas the heavy bars ran from 26 per cent to 35 per cent. This lack of uniformity would more quickly justify condemnation of the 1-inch slab than would the reduced elongation and reduction of the latter, for, as will be seen, these two characteristics are to some extent offset by the increase in elasticity and tensile strength of the bars made from the smaller blocks.

Evidently our theory explaining the better performance of the cylindrical bars compared in Table III was untenable, and no better one can now be advanced by the writer. The essential fact is that a bar attached below a casting 1 inch thick will give trouble occasionally.

Conclusion.

From these experiments, the following conclusions seem warranted:

First—That a steel test bar should not be cast vertically because of segregation, for while there may be a limit to the depth of this concentration of the elements, the extended length of a bar, if designed long enough to provide a test piece below the point where this action takes place, would make it of awkward and expensive shape. Some metallurgists have claimed that quick cooling greatly reduces and sometimes prevents segregation, and these might argue that by such mechanical means this fault could be guarded against. But the trend of present-day opinion confirms Prof. Stoughton's claim that no definite knowledge is at hand concerning this point.

Second—That a cylindrically shaped bar, attached below the casting proper by a neck as wide as ¾-inch, is preferable to a rectangular bar, because it has greater ductility than the latter.

Third—That bars will show much better uniformity and ductility if the castings attached above have 3 inches of depth at that point, than if of lesser depth.

It only remains to be stated that in the tests here reported, the elastic limit was recorded from the "drop" of the beam, that all the specimens tested analyzed close to 0.19 per cent carbon, and were not annealed.

WEIGHTS AND COSTS OF BRASS FROM AN OLD MEMORANDUM BOOK

BY JAMES M. BETTON

AS AN interesting comparison of past prices and weights of some common article of manufacture, the following notes are reproduced from an old note book, kept for his own information by a partner in one of the largest firms manufacturing brass castings for steam and water, in the early 60's. These are of interest as showing the cost of metals and the weights of certain standard goods during a period when competition had not forced the shaving and scraping of patterns to the limit.

The concern that manufactured these goods made money and prospered, as did its successors, until a younger generation, induced by increased competition, was lead to undue expansion, and the inevitable fall. The business continues today on the same site, under necessarily changed conditions, and its ownership does not include a single one of the descendents or kin of any of the original owners or their successors.

Price of Steam Cocks.

Under date of June, 1861, steam cocks, at 40 off, were quoted at the following prices per pound:

Size, inches.	Cost, cents.
½	64
¾	68
1	60
1¼	60
1½	50
2	46

This is an average price of 58 cents per pound. Globe valves of cheap pattern at 50 off, averaged 53 cents per pound including the wheel and in sizes from ½ to 2 inches.

Labor Cost.

On Jan. 20, 1863, the cost of labor for the manufacture of double flanged, steam metal cocks was as follows:

Size, inches.	Cost, cents.	Weight, pounds.
1	0.33	12½
1¼	0.50	—
1½	0.62	17
1¾	0.80	—
2	0.92	29
2¼	1.15	—
2½	1.50	35
3	1.75	51

Cost of Metals.

A comparison of the cost of metals is afforded by the following formula for steam metal, under date of Feb. 1, 1863:

Pounds.		Cents.	Cost.
40	copper at	35	$14.00
3	tin at	46	1.38
11½	lead at	9	0.14
1	zinc at	9	0.09
45½	pounds, cost		$15.61,
	or 35 cents per pound.		

Under date of Nov. 1, 1862, brass, consisting of

Pounds.		Cents.	Cost.
16	pig metal at	14	$ 2.24
25	ingot copper at.....	30	7.50
8	spelter at	61½	0.52
49 pounds, cost			$10.26,

or 21 cents per pound.

It also appears that 1,655 pounds pig metal cost $11.07, for only labor and coal, or about ¾ cent per pound, making the cost of the scrap metal about 13¼ cents.

Under date of March 28, 1864, the cost of steam metal is given as 40 cents, and brass, 30 cents per pound, with no charge for labor, while on June 28, 1864, steam metal castings cost 55 cents, bibb metal, 47 cents, and brass, 46 cents per pound.

Detailed Cost of Manufacture.

The price of molding sand, Aug. 18, 1864, was $5.00 per load of 3½ barrels, in New York. The following detailed costs appear under date of Aug. 18, 1896:

PLAIN BRASS BIBBS, PER DOZEN.

Size, inches.	Weight, pounds.	Price, cents.	Labor.	Tapping, reaming, etc.	Overhead, 20 per cent.	Tax, 6 per cent.	Total cost.
⅜	10.8	34	$1.08	$0.46	$1.02	$0.37	$ 6.50
½	15.12	34	1.20	0.49	1.41	0.51	8.97
⅝	18.6	34	1.32	0.58	1.63	0.58	10.36
¾	22.14	34	1.44	0.64	1.97	0.71	12.54
1	34.8	34	1.92	0.76	2.88	1.04	18.33
1¼	63	34	4.80	1.68	5.58	2.01	35.40

A foot note states that 38 cents per pound was the average price of the metal.

The cost of heavy steam cocks, of steam metal, is given in the following:

STEAM METAL GLOBE VALVES.

Size inches.	Weight, pounds.	Price, cents.	Iron.	Labor.	Overhead, 20 per cent.	Tax, 6 per cent.	Total cost.
¼	¾	40	$0.01	$0.29	$0.12	$0.05	$0.77
⅜	1	40	0.02	0.33	0.15	0.05	0.95
½	1½	40	0.03	0.34	0.20	0.07	1.24
¾	2¼	40	0.05	0.39	0.27	0.10	1.71
1	3¼	40	0.07	0.45	0.36	0.13	2.31
1¼	5	40	0.09	0.49	0.52	0.19	3.29
1½	7	40	0.13	0.54	0.69	0.25	4.41
2	11	40	0.16	0.65	1.04	0.38	6.63

In the foregoing the charge of 20 per cent, to cover fixed charges, as interest, rent, insurance, superintendence, maintenance of plant, and the like, reflects the simple and inexpensive manner in which business was then conducted. Twelve years later, this charge had advanced to 33 1-3 per cent, under a new management, and the selling cost was a further addition.

The charge of 6 per cent, designated as a "tax", possibly represented an internal revenue tax on the factory production, for in those days the country was groaning under the burdens of the civil war, and revenue to meet the great indebtedness was drawn from many sources. This work was done in a quiet New England village, where the brass works furnished employment for nearly all of the men, principally of American birth, with a good number of Irish, all of whom took pride in their work and in the prosperity of the village—a hard working, intelligent and thrifty community.

The work was given out to contractors who were furnished with tools, and who hired their own men, subject to the approval of the superintendent. The contractor gave to the timekeeper the weekly time and rate of his men, who were paid by the firm, the amounts being charged against the contractor, who received any balance after deducting wages. The work was carefully inspected, prices were maintained for contract work, labor got a satisfactory return, and the careful contractors made money, owned their own homes and the village was prosperous.

PYROMETRY IN THE ANNEALING ROOM*

The application of scientific methods to the production of malleable castings---The use of the pyrometer for controlling annealing temperatures

BY S. H. STUPAKOFF

THE satisfactory production of malleable iron castings depends to a large extent upon subjecting the hard castings to a suitable heat treatment which effects a transition of the originally white iron into the well known soft gray-black variety with surprisingly different physical qualities. It is in the latter state in which it is brought on the market, and it is perhaps the only one of its different phases that is known by the user. The change from hard white into soft gray-black, or "black heart" iron, as it is often called, is effected by a prolonged reheating of the castings, commonly known as the "annealing" process. The annealing or softening of the material is really the principal object sought. However, this softening is only coincident with other chemical changes that take place during this process, which are in truth the primary results of reheating the hard white iron for a specified length of time within definite limits of temperatures. Other physical changes that occur during the same period, such as increase in ductility, elongation, bending moment, tensile strength and malleability, are of even greater value and importance to the subsequent application in the arts of this excellent variety of iron.

It is not the intention to dwell here upon the composition of malleable iron mixtures, as they have been discussed at length by acknowledged authorities on the subject. It is sufficient to state that the mixture consists essentially of a low carbon iron with about 0.70 per cent to 1 per cent silicon. The iron when melted under suitable conditions will, after casting, turn out with a silvery white fracture, and extremely hard and brittle. In this condition it is almost absolutely useless for any purpose. Nearly the whole of its carbon content is present in the combined state, in other words, chemically combined with the iron. The object of the annealing process is to break up this combination and to transform the combined carbon into a non-crystalline graphitic state. As such it will then be present in the iron merely as a mechanical

*Presented at the Cincinnati convention of the American Foundrymen's Association.

mixture and provided all other conditions are equally favorable, the result will be a malleable cast iron with its well known good qualities.

Hence, during the annealing process we are breaking up a chemical combination of iron and carbon, opposing to the gigantic forces of chemical affinity the subtle agent of heat. Yet, just as the constant dropping of water will hollow the hardest rock, so will the incessant attack of heat pull and push about the infinitely small particles of unrelated materials until each occupies its proper abode. This, however, is by no means so simple a process as the annealing or hardening of tool steel, whereby the carbon and iron-carbon contents are merely changed from one allotropic state into another, and which might be compared for the sake of illustration to changing liquid water into solid ice or into its gaseous form—steam. Either one of these results may be achieved within a comparatively short time by rigidly observing the conditions which are necessary to place the molecules of the material in their desired states of allotropy. There is much more accomplished in the annealing process of malleable cast iron and the changes aimed at during this operation are of a much more radical nature, so that it should not be strange to note that it involves the factor of time as well as that of high temperature.

Researches on the constitution of iron and steel are as recent as 25 years ago, and lie within the memory and practice of most manufacturers of the present day. Little, however, was dreamt of the nicety of equilibrium to which the constituents of our materials must be poised in order to obtain the best results in our products. The knowledge of what can be accomplished by judicious treatment has spread like wild-fire throughout the world, manufacturers and consumers alike being fully aware that no product can find a place in the open market of today, unless it comes within the narrow limits of the most rigid of specifications. The manufacturer is compelled to meet the just demands of the wide-awake buyer, who is as well, and often better, informed of modern possibilities as he is.

Changes in Structure.

We know that no radical changes from the state of combined carbon to that of graphitic carbon can take place in any of our numerous iron compounds below a certain place in our temperature scale. And we know likewise that the same transition cannot be accelerated after a certain highest point of the scale has been reached. The definite region where such a change commences to become noticeably active is known as the critical range. Its location varies slightly up or down the scale, according to the composition of our material, though in iron and its compounds it depends principally upon its higher or lower percentage of carbon. It is safe to say that its lowest limit does not fall very far below 700 degrees Cent., or about 1,300 degrees Fahr., and its upper limit does not exceed 900 degrees Cent. or about 1,650 degrees Fahr.

It is quite true that there exists a constant transmigration and re-arrangement of the smallest particles (the molecules) of our iron compounds at far lower, and perhaps at all temperatures; but they are of no moment to the producer nor to the user of malleable iron. They may be of scientific value, but they are certainly too insignificant to be taken seriously into consideration in practice. This is far different when we come to deal with some of the physical changes which take place in the course of time in some of our steels. And we may refer particularly to some special finished products used for electrical purposes, as permanent magnets. It is well known that these assume their permanency only after a considerable lapse of time—several months, which again depends upon conditions of temperature at which they were kept to age them. And it is equally well known that this so-called ageing of steel can certainly be effected at as low a temperature as that of boiling water. However, a change of the molecular arrangement of the constituents of iron or steel, as that of changing one form of carbon or iron, or their compounds, into other allotropic forms, can only take place at considerably higher temperatures.

These remarks are given here merely to show that, after all, we are not dealing in our commercial iron and steel with as exceedingly simple bodies as they are ordinarily assumed to be. In fact, as soon as we attempt to delve into the profound depth of their molecular constitution, as soon as we lay bare the laws of their existence and try to explain the phenomena we see, we meet with almost insurmountable obstacles and perplexing complications.

And as the course of the practical man lies along the path of all these uncertainties, is it not most natural that in his dilemmas he should call in the aid of the scientist for his enlightenment? The first advice that he receives is to abandon his old hit and miss methods. All steps in the manufacture of his products must be conducted upon the basis of correct principles. There is no possible chance of attaining the desired ends if it is attempted to accomplish miracles, or what is the same, to attain definite results by means which are contrary to natural laws.

The manufacturer of malleable cast iron has long since submitted to the necessity of relying upon the services of a trustworthy metallurgist, who selects his mixture from among various grades of iron, calculates the necessary quantities of each, basing his work on a careful chemical analysis of the raw materials as well as of the product. But the conscientious chemist is fully alive to the fact that the best brands of iron, the most suitably compounded mixture and the most carefully executed analysis alone will not result in a good product. There is the melting process in all its details to be duly taken into consideration, and this is usually left to the "judgment" of the melter. Last, but not least, we have in the annealing process one of the most important stages in the production of malleable iron which govern the physical qualities and the commercial value of the product.

And these all-important stages of heat treatment of malleable iron are left—even now—in many establishments, to the fallacious personal judgment of a few operators, whose principal qualification is that they have grown up in the business. Who would question the fact that the success or failure of each individual heat in foundries conducted on these lines depends almost exclusively upon the personal skill, the good will, state of health, mind and disposition of a few trusted employes?

The Practical Man's Limitations.

The *Electrochemical and Metallurgical Review* published in October, 1906, an editorial that fully covers the situation. It is an exposition of close observation and a masterpiece of deep thought, common sense reasoning and full of expression, which the writer recommends to the careful consideration of all the manufacturing world. It says:

"The practical self-made man has acquired a faculty of feeling or perceiving by intuition whether his process works correctly or not. Such knowledge is stored in him and it will die with him. This fact makes him liable to underestimate or wholly misunderstand the value of scientific meth-

ods. This is his mistake. But in many cases if we see what has been accomplished simply by consistent hard work with rule-of-thumb and try and miss methods, we can not but admire the man who did this work. Yet it remains a self-evident truth that we must get away from the rule-of-thumb, and must use instead exact scientific principles. The times have marvelously changed, and while we must admire the 'practical man' of the past, the future belongs to the man whose work is based upon scientific principles. The practical furnace man in a metallurgical works of the past saw with his eyes whether the metal was at the right temperature. He did his work faithfully and successfully, but when he left the plant his knowledge went away with him. Now in the period of pyrometers, a works is enabled to get a permanent record of the right succession of temperature during a process. It is thus possible to repeat a successful process from the written record after success has once been established—and the plant is independent of the individual man. This illustrates clearly the industrial progress which has been made, and which is wholly the result of scientific progress."

And this is the very point aimed at in this paper. It is the intention to impress upon all interested parties that, since trustworthy instruments are available for following up the various stages of the heat-treatment of our materials, we should use them freely and intelligently and thereby become independent of the personal factor. Even the best of such services, most faithfully given, can not be free from mistakes. And errors, whatever their cause, and whatever their extent, cost more or less money. This money is lost by the manufacturer alone, while the wages of the mechanic go on as if nothing had happened. And the same pleasant relationship prevails until one or the other of the two parties concerned tires of it and steps out. Then there is change for worse or better. A new hand steps in, and he is given a chance for a month or more—at the expense of the manufacurer—to become acquainted with the methods, the appliances, the working of the furnaces and the running of the plant. After that it depends in part upon his experience and his skill, but especially upon his "good luck," whether there is a material improvement in the quality of the product and in the profits of the business or not.

But why depend upon the fallible judgment of the individual if there is no necessity for it? There is ample opportunity for the mechanic to make good use of his skill in other directions than "guessing" at the most suitable thermal conditions during the various stages in the manufacture of his products. This task lies not within his province, it extends beyond the limits of the unarmored senses of man. Man's senses were never intended for such conditions, they were not developed for it, they are not adapted to it, and they are not fit for it.

Fallibility of the Senses.

The easiest manner to prove these assertions to you by your own experience may be by recalling a few well known examples from physics, which every one of you has learnt while still at school. Step from broad daylight or from a brightly illuminated space into a dimly lighted room, and all things appear indistinct, whereas you can recognize without trouble even the smallest details if you enter the same room from the dark. Touch in a Turkish bath room with your bare hands or feet substances of different natures, like straw matting, woodwork, stone flooring or metals, and you will experience remarkably different sensations. They may lead you to think that all have widely differing temperatures, whereas the application of a thermometer to either one of them will show you that the temperature of all is exactly alike. Make the same experiment in a refrigerating room, and you will experience sensations of an exactly opposite nature. Fill three basins with water, one at 32 degrees, the second at 90 degrees and the third at 160 degrees Fahr. Place both hands in the basin with water at 90 degrees. After a short while you will not be conscious that your hands are in contact with anything; you will feel no heat. Then plunge one hand into the cold water and one into the hot, keep them there until they have assumed these temperatures, and then change both hands over into the water of 90 degrees. Now, if you were to believe your senses, one of your hands would make you believe that the water is hot, and the other one that it is cold.

Example after example of the same or similar nature might be cited, every one of which would furnish you with positive proof of the fallacy of our senses; but I believe that the above, which have been selected from the ranges within our natural state of condition, should be sufficient evidence to you that it is entirely beyond us to approach with our judgment even approximately within reasonable limits of conditions that lie out of reach of our unprotected or unarmored organs.

This object can be attained only by the employment of suitable physical instruments, and in our present particular case by the judicious use and correct application of high temperature measuring instruments. We can make our selection from among a number of different types.

Instruments Available.

The Siemens water pyrometer, which was perhaps the first practical instrument for the purpose, is somewhat out of date, but still as good as any if used intelligently. It is not as convenient as the more modern types of pyrometers; it gives no permanent indications of prevailing temperatures; it can not be handled easily by an ordinary workman, and it takes from 15 minutes upward to determine the temperature desired. But, when carefully handled, its reliability comes fully within admissable limits of malleable iron practice, and it is certainly reasonable in price.

Seger's cones or Wiborgh's thermophones may be used in annealing furnaces to some advantage in cases of emergency, if no better means are available. They will serve to give an approximate indication of the time when the highest admissable temperature has been reached. They are only good for a single application and must then be replaced by new ones. But they are cheap and they can be handled by an ordinary workman. It is good practice to keep a few sets of these little tell-tale cones on hand, whether there is an immediate use for them or not. Conditions are sure to arise sooner or later in the best regulated establishment when it will be considered a blessing to be able to lay one's hands on them.

Mercury thermometers are now obtainable, reading up to nearly 1,000 degrees Fahr. They are made of a special grade of (Jena 59^{III}) hard borosilicate glass, and are nitrogen filled. They lie below the range of malleable iron annealing furnaces, but they may be useful for regulating the temperatures of core ovens, and they are sometimes quite serviceable for application in some stacks and flues. They are made in a number of different shapes and when equipped as mechanical fixtures they are adapted to be permanently applied suiting various conditions. It is obvious, that, owing to the fact that they are partly constructed of glass, careful handling is necessary to avoid breakage.

Mechanical thermometers form a

distinct class of heating measuring instruments. They are mostly constructed upon the basic principle of the unequal expansion of two different metals when exposed to varying degrees of temperature. The expansive force is transmitted to a pointer which moves over a graduated scale just like the hands of a clock or that of a pressure gage. These instruments are constructed entirely of metal, except that the pointer and dial are covered by a disc of glass. They are rugged, are not easily damaged, reliably accurate within fairly reasonable limits, and suitable for indicating temperatures up to about 600 degrees Fahr. They are therefore adapted for use in malleable iron foundries in core ovens which are well under control, in pitch and enameling furnaces, in high and low pressure steam lines which may be used for drying, for heating or for any other specific purpose that comes within their range.

It may not be out of place to state here parenthetically that "thermometers" include all instruments for any range of temperature from the lowest (the absolute zero) up to the boiling point of mercury (676 degrees Fahr.), while others that are adapted for ranges higher than this point are usually designated as "pyrometers."

Expansion pyrometers are constructed upon the same general principle as the foregoing class of mechanical thermometers, but as their name implies, they are intended for higher ranges of temperatures. They enjoyed for many years quite an extensive distribution and use in many branches of the industries, but within the last two decades they were compelled to make room for the more modern types of instruments. When used for short periods of exposure up to within moderately high limits they give reasonably close indications. The claims usually made for them should be accepted with caution, and it is always advisable when using them in practice, to remain considerably below their given maximum to avoid permanent setting of their vital parts. Provision is made in most instruments of this type to take up a permanent set by means of adjusting screws. However, before these means for readjustment are resorted to it is necessary that the instrument be allowed to cool to normal temperature.

Electric resistance pyrometers are of modern construction. They are exceptionally sensitive to small variations of temperatures, and they give very close and trustworthy readings when judiciously used within their limits. They must not be exposed to temperatures above 1,200 degrees Cent., as this would cause a permanent change in the resistance of their vital parts, necessitating recalibration. Their usefulness extends consequently over the whole range of annealing temperatures, but not high enough to be practical for measuring the temperatures of iron and steel and their alloys in the molten state. The active portion of these pyrometers, consisting of a coil of fine platinum wire, must be protected against the action of furnace gases by an impermeable sheath or covering. And as there are no highly refractory substances which will accomplish this except some special porcelains or pure silica, which are all of a brittle nature, it stands to reason that these instruments must be carefully handled. This, however, is a feature present in all high class temperature measuring instruments that are directly exposed to the sources of heat. It is unavoidable, and this alone should be no good reason that they be condemned and barred from use in industrial establishments.

Thermo-electric pyrometers compose another distinct class of modern high temperature measuring instruments. They offer many advantages over others of their kind. They are certainly the simplest in construction, they are easily handled and easily applied, and they can be used in numerous instances where it would be impossible to make use of pyrometers of any other type.

Unreliable Instruments.

The fact that almost any two metals of different nature or of different composition, when joined, will cause the appearance of thermo currents upon heating this junction, has induced many enterprising firms to place instruments of this kind upon the market which are supposed to offer many advantages over others that have earned deservedly universal reputation. However, in the majority of these imitations (?) the fact has been overlooked, that the physical quality of changing heat waves into electrical waves alone, even if applied to practice by the most skillful mechanic, is not sufficient to produce a reliable scientific instrument for "measuring temperatures." It is true, there are some that are quite trustworthy within their specified limits, but for most of them entirely too much is being claimed. This does more harm than good, and it is quite frequently the cause of arousing suspicion as to the reliability of the better class of instruments of their kind. There is no question that it would contribute considerably to the general spread of practical pyrometry, if the distribution of such faulty instruments would receive less encouragement. The writer has in his possession a report from the highest authority on such matters on the test of one particular make of these thermo-couples, which, by the way, are extensively sold in this country, that says among other things: *"They are not at all suitable for the measurement of temperatures."* There is no doubt that our own highest court of appeals in such matters, the Bureau of Standards, at Washington, D. C., would corroborate the above if its opinion should be solicited.

There is an amazingly small number of materials among the 70 odd elementary substances and their innumerable combinations that, when connected in pairs, will meet all the requirements of a good thermo-electric pyrometer. One of the best so far devised is that consisting of one wire of pure platinum and one of pure platinum alloyed with 10 per cent rhodium as suggested by Professor Henry Le Chatelier, of the School of Mines, Paris, France. It is considered by all physicists the standard of measurement for high temperatures up to about 3,000 degrees Fahr., and it unquestionably supersedes all others in constancy and accuracy from about 300 degrees Fahr. to its upper limit.

Thermo-Couples.

Among thermo-electric couples there may be further mentioned the iridium-ruthenium and the platinum-iridium couple. The former can be used for temperatures higher than 3,000 degrees Fahr., but it is exceedingly brittle and therefore not well adapted for use in industrial works, though it is undoubtedly of a high scientific value. Platinum-iridium couples have a smaller range than Le Chatelier's platinum-rhodium couples. This is owing to a change of their thermo-electric constants which occurs at about 1,800 degrees Fahr. on account of the volatilization of the iridium that commences about at this stage. Trustworthy for lower ranges of temperatures are copper-constantan, silver-constantan and iron-constantan thermo couples. Constantan is an alloy of 60 per cent copper and 40 per cent nickel. Neither one of these latter couples, however, can be seriously recommended for use above 650 degrees Cent. or 1,200 dgrees Fahr.

Optical pyrometers are constructed upon the laws of relationship between

heat and light. They are in fact instruments that measure the degree of light that is emitted by a hot body, and this is transposed by some convenient means into degrees of temperature. It would seem that this method offers a decided advantage over other instruments made for the same purpose, inasmuch as the instrument is not required to be brought in direct contact with the source of heat. But this property alone, if not combined with simplicity of construction, ease of handling and maintenance would not fill the requirements of every day shop practice. At the present time there are but few commercial optical pyrometers that possess these qualities combined, and most of them remain therefore so far only excellent laboratory instruments, which in the hands of a careful operator give surprisingly accurate results within ranges that are far beyond the reach of other instruments for the same purpose. There are, however, a few types of optical pyrometers made that are very simple in construction and easy of manipulation, which may be used by almost any man of ordinary intelligence. But it should not be forgotten that due allowance must be made in all optical pyrometers for personal errors of observation which vary sometimes considerable with different, and occasionally even with the same individual observer.

Radiation pyrometers, like optical pyrometers, are used at a distance from the source of heat that is to be measured. They are therefore not subject to destruction by fire or furnace gases and will last indefinitely if guarded against mechanical injury. No part of the instrument is ever heated above 80 degrees Cent. or about 180 degrees Fahr. Their construction is based upon the principle of measurement of the total radiations of heat—not light, as in the foregoing—of substances located under conditions known as those peculiar to a black body. The heat rays are collected by a mirror located within the instrument and, then concentrated into a focus where the hot junction of a sensitive copper-constantan couple changes them into electrical waves, the electromotive force of which is subsequently measured by a sensitive d'Arsonval galvanometer. The scale of this indicator is expressed directly in degrees Fahr. or Cent., as the case may be, and there is no transition of the values into any other denomination necessary. This makes the instrument a very convenient contrivance for the direct determination of the highest attainable temperatures.

Miscellaneous pyrometers based upon the laws of expansion of air, the dilution of liquids and gases and the variation of the viscosity of gases—all under different conditions of temperature—have also been made, and have found some application in practice, but in a comparatively limited way only. The graduation of these instruments is purely empirical, as they are somewhat cumbersome, more or less complicated and expensive. It is certain they have not found much favor in annealing practice, and they are rarely—if at all—found in malleable iron or steel foundries.

Fusible alloys, made of precious metals, have been occasionally employed for the determination of high temperatures; but, excepting in dentistry, their application in practice has been almost entirely abandoned. Therefore it would appear that merely mentioning them here should answer our purpose. This ends the list of high temperature measuring instruments. All have had their share of fair trials, some have found practical application in our industrial establishments, and, though it can not be said that our tests have been concluded, there are at the present but a remarkably small number of types that have gained a solid foothold in our factories with fair prospects for permanence.

Recording Devices.

The equipment of all mechanical and electrical pyrometers includes necessarily a suitable indicating or recording device. That class of instruments mentioned as expansion and contraction pyrometers and thermometers have their mechanism for moving a pointer over a graduated dial directly connected to the operative portion of the end exposed to heat. The pointer of recording instruments of this type, which carries a writing pen or pencil, is connected likewise, and the latter bears permanently against a sheet of paper usually rotated by clockwork, and arranged either as daily or weekly records. The expansion and contraction of the substances which form the vital parts of these instruments furnishes ample power to admit a permanent contact of the writing pen with the paper without introducing material error. The result is therefore a continuous uninterrupted line which represents graphically the conditions of temperature with relation to time of the entire heating process.

In electrical pyrometers we have but a very small amount of power at our disposal for moving a pointer over a scale and for recording the corresponding temperatures. Resistance pyrometers are used in connection with a Wheatstone bridge to determine the change in resistance of its sensitive portion which is dependent upon its temperature. Millivoltmeters serve mostly, in thermo-electric pyrometers, for the measurement of the electro-motive force of the thermo-currents which in turn stand in certain relationship to the temperature prevailing at their points of junction. Radiation pyrometers which are also constructed upon the thermo-electric principle have the same means of measurement.

Recording instruments for these pyrometers embody the same electrical apparatus as their indicating instruments, and besides this a clock work with paper and style imprint movements. In recording instruments for resistance pyrometers, subsidiary currents from batteries or motors may be used for furnishing any amount of power that may be necessary for the pen, paper and imprinting movements. It is thus possible to produce uninterrupted continuous line diagrams on the record paper. In recording instruments for thermo-electric and radiation pyrometers, however, we are solely dependent upon the feeble thermo-electric currents for operating the movable portions of our galvanometers or millivoltmeters, and consequently we are compelled to rely upon these alone to produce permanent records in this class of instruments. This object can only be attained by resorting to periodic depressions of the style bearing the indicating needle. In this manner the records become line drawings that are composed of consecutive markings, which, according to the specific arrangement used, may combine either into a continuous line, or be represented by a series of dots which show continuity and dependency from each other in the completed diagram.

Advantages of Records.

The advantage of continuous autographic records, which give a truthful and lasting representation of all details accompanying the entire course of a process of heat treatment must be apparent. It furnishes the means to trace irregularities or negligence in the running and attendance of our furnaces and ovens; it serves to detect the causes of faults in the heat treatment of our materials that result invariably in unsatisfactory products; it suggests to us what steps are to be taken to correct such faults and to improve the quality of our products and it makes it possible to systematize our entire methods of heat treatment,

RULES FOR OBTAINING SURFACE SPEEDS.

To find surface speed in feet, per minute, of a wheel:

Rule:—Multiply the circumference in feet by its revolutions per minute.

Surface speed and diameter of wheel being given to find number of revolutions of wheel spindle.

Rule:—Multiply surface speed in feet, per minute, by 12, and divide the product by 3.14 times the diameter of wheel in inches.

RULES FOR CALCULATING SPEEDS AND DIAMETERS OF PULLEYS.

Proposed speed of grinding spindle being given, to find proper speed of countershaft.

Rule:—Multiply the number of revolutions per minute of the grinding spindle by the diameter of its pulley, and divide the product by the diameter of the driving pulley on the countershaft.

Speed of countershaft given, to find diameter of pulley to drive grinding spindle.

Rule:—Multiply the number of revolutions per minute of the grinding spindle by the diameter of its pulley, and divide the product by the number of revolutions per minute of the countershaft.

Proposed speed of countershaft given, to find the diameter of pulley for the lineshaft.

Rule:—Multiply the number of revolutions per minute of the countershaft by the diameter of the tight and loose pulleys and divide the product by the number of revolutions per minute of the lineshaft.

TABLE OF GRINDING WHEEL SPEEDS.

Diameter of Wheel, Inches.	Revolutions per Minute for Surface Speed of 4,000 feet.	Revolutions per Minute for Surface Speed of 5,000 feet.	Revolutions per Minute for Surface Speed of 6,000 feet.
1	15,279	19,099	22,918
2	7,639	9,549	11,459
3	5,093	6,366	7,639
4	3,820	4,775	5,730
5	3,056	3,820	4,584
6	2,546	3,183	3,820
7	2,183	2,728	3,274
8	1,910	2,387	2,865
10	1,528	1,910	2,292
12	1,273	1,592	1,910
14	1,091	1,364	1,637
16	955	1,194	1,432
18	849	1,061	1,273
20	764	955	1,146
22	694	868	1,042
24	637	796	955
30	509	637	764
36	424	531	637

The revolutions per minute at which wheels are run is dependent on conditions and style of machine and the work to be ground.

THE FOUNDRY DATA SHEET, OCTOBER, 1909.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

removing the responsibility from the overburdened shoulders of our expert operators. It makes us independent from them and allows us to place such responsibility without hazard and with far better chances for continued future success into the hands of green—though conscientious—common laborers. A series of records illustrating the heat treatment of our materials, intelligently marked with notations as to the physical qualities of the resulting products are unquestionably the best, if not the only means or the most reliable method for predetermining qualities that will be obtained under certain conditions; for establishing set rules as to the most economical, the most efficient, and the most reliable mode of running our various furnaces and ovens that will give us the best possible guarantee of definite results, and eventually for repeating previous processes which have proven satisfactory in imparting the resulting product with the most desirable good qualities.

This can not be readily attained by the use of an indicating instrument alone, unless its indications are noted down at regular short intervals by a trustworthy employe who has been especially detailed for this purpose. Non-recording instruments, however, are a necessity in the hands of men in charge of our furnaces or ovens. They will serve them as reliable guides and advisors that will furnish correct information of existing conditions, and they are their only means of reference as to what they are to do in order to strictly follow given instructions.

Uses of Pyrometers.

The principal use that pyrometers find in malleable cast iron foundries is for regulating the temperature of annealing ovens, and especially for regulating the temperature of the malleable castings themselves during the anneal.

It has been pointed out that large variations in temperature are apt to occur at different portions of an annealing oven. Such a state once existing, it remains practically constant, unless adequate means are provided to equalize the irregularities. It is but natural that the charge itself is subject to entirely different conditions. There is usually an enormous mass of cold material heaped up in the interior of the oven that is packed in suitable boxes, which are arranged in several rows two or three high; and such a mass can not possibly be heated uniformly by ordinary methods. Such portions of the charge as are most exposed to the direct action of the hot gases must necessarily absorb a larger quantity of heat than others that are less exposed. The lower and central portion of the charge is least accessible to the action of the current of hot gases, the flow of which is usually directed from one side wall to the other of the oven. This is what retards the anneal and determines its duration. The heating of this portion of the charge is almost exclusively effected by the slow processes of conduction and radiation. The upper portions of the annealing boxes and their contents, however, are easily overheated should the firing exceed the admissable limit. These are conditions which can not be entirely avoided in ovens of large dimensions, but much may be done towards reducing the time of anneal by reconstructing the ovens, by changing the method of charging the ovens, and by accommodating the practice of annealing to suit these ends.

In reviewing the situation it must occur to one that the selection of the place where a pyrometer should be introduced into an annealing oven, in order to obtain by its aid the most serviceable information as to prevailing conditions, is of considerable importance. We have seen, that at best, no more should be expected from a good pyrometer applied under such conditions than a reliably correct indication of the temperature of a single part or section of an oven. It serves therefore as a trustworthy guide that at no time the temperature may be allowed to fall below or rise above specified limits at this particular place. The regulation of the fires must remain with the attendant. He is relieved from the responsibility of using his own judgment and from guessing at existing temperatures. The pyrometer, galvanometer or indicator is his heat gage, and the position of its pointer his guide which tells him when it is time to increase or decrease his fires, just as the pressure gage on a boiler reminds the stoker or fireman of his duty.

A far more radical method to ascertain and to follow the changes of the thermal conditions of an annealing process is to measure the temperature of the material itself. This may be connected at first with some difficulties, but it is by no means impractical. It is certainly the true way of proceeding if one would obtain positive results which may serve as a suitable basis to lay down iron clad rules for the allowable maximum limitations of our heating process. The writer is not aware that this has ever been attempted in malleable iron practice, but he had the opportunity to assist in developing some methods after this principle for the annealing of sheet steel. The results proved to be very satisfactory, and, in fact, it was found to be the only reliable means to produce superior brands of electrical steel, which could not be obtained by other means.

Application of Methods.

In applying such methods to the annealing of malleable iron it would suggest itself that the temperatures of the hottest and the coldest portions of the charge be followed up regularly. And as we should be informed of the respective temperatures of the malleable iron castings themselves, our measurements should be taken at the interior of the annealing boxes. This can not be done unless a few—say two or three—boxes of each charge are specially fitted up for the purpose. The arrangement does not require anything elaborate. A suitable rigging would be an iron or steel tube half as long as the width of an annealing box, secured to its interior opposite a corresponding opening left in its side, of which it forms a continuation, extending inwardly like a thimble. The inner end of this tube must be closed, and the outer one may be provided with a flange which can be held in place against the inside wall of the annealing box by a wedge that fits between ribs, arranged for the purpose. The joint between box and flange of the thimble is luted with fire clay to prevent air and gases of combustion from entering. These test boxes are arranged in such a manner that the described thimble-like tubes stand in alignment with observation holes left in the walls of the annealing oven. The thimbles themselves are arranged as nearly as possible in a horizontal position for all types of pyrometers except for those constructed after the radiation principle, when they should incline upwardly with their inner closed end, so that a line drawn from this point through the observation hole of the furnace wall will fall with its outer end about five or six inches lower.

The rest is easy. Any suitable form of pyrometer is introduced with the necessary precaution into the interior of these boxes, or the telescope of a radiation pyrometer is focused to the bottom of the thimble, and the indications received will be the temperatures that prevail at these particular places, and not those of the furnace or of the surrounding furnace gases. It would seem that this or some similar

method is the only correct way to ascertain the temperature of the castings themselves.

The above dwells especially and specifically on the application of pyrometers in annealing practice, and apparently with good reason, as it is in this particular process where these instruments undoubtedly find the most extensive use, and it is here where they should prove of the greatest value if properly applied. But aside from this there are many opportunities of making good use of them at other places in a malleable iron foundry. It is not the intention to enter here into the details of such varied applications, as each of these furnishes ample material for subsequent papers which can not be taken up at the present time. Suffice it to say that pyrometers can be also applied to excellent advantage for the regulation of melting furnaces, for the examination and most advantageous distribution of checker works in open-hearth or regenerator furnaces, for flues and stacks, for the melting and pouring of iron, as well as in core ovens and in the laboratory of the chemist.

We make a clear distinction between these two intimately related heating processes, for it is well understood that the temperature of the furnace does not represent the temperature of its contents. There may be wide variations between both, and again, they may approach each other very closely. It is neither at all likely that the temperature in an annealing oven is uniform throughout, though in some exceptional good instances—as in pit furnaces—there may exist no greater variations than 50 degrees Fahr. in its various portions. This, however, is a rare occurrence. It is found more frequently that different portions of the same oven vary from 100 to 300 degrees Fahr. and upward. It is quite feasible that under such conditions no satisfactory results can be obtained in the product, in which uniformity is one of the principal requirements. This is the first application in which we can make good use of our pyrometers for equalizing the temperatures in our ovens as closely as may be. Prevailing conditions are reliably indicated by applying one or more pyrometers at different portions of the installation, and such conditions being once established and known, it becomes an easy matter in the hands of a practical furnace man to regulate his own temperatures by enlarging some of the flues or by chocking others, by opening or closing dampers, by increasing or decreasing the supply of fuel or air, or the draft in the stack, by luting up cracks in the walls or around the doors, and in other ways for which no set rules can be given, but which will readily suggest themselves in practice.

Errors in Readings.

In connection with the above it may be appropriate to call attention to a mistake which is frequently made when pyrometer readings are taken of furnaces of this or any other description. That is, such readings are usually taken for granted as representing the true temperature of the furnace, regardless of the fact whether the flame of the fuel plies against the sensitive portion of the instrument or not. This is wrong, and apt to lead to grave errors. We would expose our pyrometer to the direct action of the flame if it should be our intention to ascertain the temperature of this, but we must guard it against its direct influence if we wish to establish the state of the interior of our furnace. And, as it takes rarely more than a fraction of a minute to take such a reading, it will be advisable to turn off the fires while making tests of this nature.

We know that it takes a long time before our annealing boxes and their entire contents "come up" to the heat of the oven. The oven may have had the right temperature many hours before even the most exposed portions of the boxes approach the same. In uniformly working ovens after a sufficient lapse of time, and by judicious firing, we succeed in bringing both to the same temperature, but if we wish to prevent any portion of our anneal from overheating we are compelled to keep on firing at a slow rate and at a low heat.

The best method of annealing consists in heating the charged material as quickly as possible to the maximum temperature compatible with the process, to keep it at this stage for a sufficient length of time to effect the desired molecular change and then letting it cool down slowly.

A considerable saving in time and in fuel may be effected by pushing the firing in the first stages to its upper limit, provided due care is being taken to make full use of the heat derived from the combustion of the fuel for heating the charge, and not sending it out of the stack. This object is rarely attained in the fullest measure. It can only be accomplished by causing complete combustion of the fuel either outside of the oven or at least before the unburnt gases have had a chance to come in contact with the large quantity of cold material that is massed up in its interior. It is surprising to learn how little economy is exercised in the use of fuel in ordinary annealing practice, or to put it more plainly, how much fuel is recklessly wasted. No knowledge of the higher mathematics is necessary, only a little plain arithmetic to show the percentage of the developed heat effectively used and that of the heat lost. This is a question worth looking into. It is dollars and cents to the manufacturer.

It is true, such problems can not be solved within a day, and perhaps not in a week, but they are not beyond satisfactory solution. It is also acknowledged that the "mere possession" of the best of all necessary instruments for checking and regulating thermal process is not sufficient. It requires their intelligent and correct application, and a fair understanding of the construction, and value of their indications.

The best service in this direction can be expected only from a trained metallurgical engineer who must be at the same time an experienced specialist in combustion and in the heat treatment of materials. However, much is to be gained without the valuable aid of such an advisor, by the intelligent application of the various excellent instruments now obtainable for the purpose, such as draft gages, gas analysis apparatus and pyrometers. Quite frequently a single one of these instruments may render material aid in improving existing conditions; as the draft, the composition of the gases of combustion and its temperature are closely related to and dependent upon each other. And as most practical men—by which I mean especially the manufacturers — are averse to equipping their works with a variety of physical apparatus, they may be satisfied as a rule with the results obtained from the use of a reliable pyrometer.

It should require but little argument to convince the user that the same equipment or the same fittings of a pyrometer are rarely suitable for temperature measurements of metallurgical processes that are of different nature or which are conducted in furnaces of different construction or design. The variety of their applications, to which reference has been made in the foregoing, should present sufficient reasons why it is impossible to devise a single universal form that would prove equally convenient and equally serviceable under all conditions. And as the success to be derived from the use of these instruments depends largely upon their

form, their fittings and their equipment, which must be specially adapted to the particular use for which they are intended, it is always advisable to leave the selection of the apparatus in the hands of a specialist in such matters.

There are many people who expect that after they have spent hundreds of dollars for a new wrinkle, of which they have heard that it served others to obtain the desired ends, their old troubles and difficulties should be overcome even before the package has been delivered. That is unreasonable. Physical instruments perform no magic. Chronic ills can not be cured in a day, intricate problems can not be solved without intent study and without intelligent application of our faculties. Results cannot be obtained without effort, and a frail system can not be built up without patient nursing. There is no easy street to success; it is strewn with many obstacles which prompt the timid to turn back, and which are surmountable only by a few selected ones, who are possessed of enduring strength and of indomitable will. Such men are ordained to become the true captains of our industries.

Patience in Acquiring Familiarity.

This is not mere phraseology, but it has direct reference to the application and care of pyrometers and other similar physical instruments which have found a way into our manufacturing establishments. They are of necessity mostly of a delicate nature, and their judicious handling and proper treatment must be learned before they can be mastered. It can not be expected that they should prove of immediate success in the hands of a novice, nor that their application should bring marvelous results the first day. They are a decided departure from other tools and appliances used in our factories. This explains why the necessary skill of safely handling them is occasionally acquired at the expense of some unfortunate breakages, which, however, are caused almost without exception by overcarefulness and consequent awkwardness. Such minor difficulties, if they should happen, must not discourage the user. They will soon be overcome after the use of the apparatus has become common practice. The instruments are certainly no more delicate than a watch, or a glass tumbler or a china cup, and nobody will give it a thought of breaking them after they become as much used to them as they are to these.

A decided turn is reached after the first superior results have been obtained; after that there will be no going backward, no trusting to the good luck of the workingmen to run furnaces and ovens without them. That is the time when it will be acknowledged that the pyrometer has come to stay.

The introduction of these and other physical instruments into our manufacturing establishments is not a mere fad or fancy, or a whimsical trend of modern times which must be lived up to in order to keep up with the fashion. It is nothing of the kind. It is a decided step forward, a means for the advancement of the arts, for the perfection of old methods, for improving the quality and enhancing the value of our products of manufacture, for predetermining results, for repeating previous successful metallurgical operations and thereby preventing failures and irreparable losses.

Let physical appliances be looked at in their true light, exclude all false misleading illumination, put them on the scale of a delicate balance in opposition to results, and their value will become more readily understood, their service will be appreciated. They will then be considered as absolute a necessity as the pressure gage on the boiler, as the chronometer and the sextant on a seafaring vessel and as the time piece in our daily life. Their present extended applications have furnished many convincing proofs of their usefulness, and while today they are an acknowledged factor in the intelligent conductance of metallurgical operations, the period is rapidly approaching when they will be considered as indispensable in malleable foundries as the shovel and the rammer in the hands of the molder.

PRODUCTION OF COPPER AND LEAD IN THE UNITED STATES IN 1908.

According to the statistics issued by the United States geological survey, the copper production in 1908 exceeded all previous records, and amounted to the enormous total of 942,570,721 pounds. It exceeds the 1907 output by 73,574,230 pounds, or 8.4 per cent. Arizona leads with a production of 289,523,267 pounds, Montana is second with 252,530,651 pounds, Michigan is third with 222,289,584 pounds, and Utah is fourth with 71,370,370 pounds.

The production of refined copper in pounds in 1908 is tabulated in the accompanying table.

The 1908 figures for domestic electrolytic include 26,786,485 pounds lake copper, which were refined electrolytically.

In addition to this production of refined copper, 9,705,103 pounds (of which 2,551,077 pounds were electrolytic and 7,154,026 pounds were casting) were recovered during the year by the regular copper-refining companies of the country from domestic scrap, drosses, etc., and returns from practically all the known refiners of secondary material indicate that 13,508,574 pounds were turned out by them as casting copper and in alloys.

	1908.	
	Domestic origin.	Foreign origin.
Electrolytic	656,179,349	218,716,268
Lake	195,503 099	.....
Casting	24 165,681	134,726
Total	875,849,129	218,850,994
Total output domestic refineries	1,094,700,123	

The production from the secondary sources in 1908 was about 23,000,000 pounds, as compared with about 60,000,000 pounds for 1907.

The production of lead in tons of 2,000 pounds was 310,762 tons from domestic ore in 1908 (against 365,166 tons in 1907), and 97,761 from foreign ore and foreign base bullion (against 76,849 in 1907). The grand total from all sources is, therefore, 408,523 tons of lead in 1908 against 442,015 tons in 1907.

PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

The first meeting after the summer recess of the Philadelphia Foundrymen's Association was held at the Manufacturers' Club, on the evening of Sept. 1. After the transaction of routine business, various foundrymen were called upon to report the condition of their trade. The consensus of opinion was that there has been a decided improvement in the casting industry, and while prices are very low, there is a tendency toward a higher level.

SALES AGENCY FOR CASTINGS.

The San Francisco Castings Co., San Francisco, Cal., is a sales corporation that has recently been formed for the purpose of enabling San Francisco foundries to bid on the work that would overtax the capacity of any one local shop. This organization has been effected in view of the large contract which was awarded by the board of public works for the standard and special fittings that are being used in the construction of the auxiliary water supply system for the fire protection of the city.

MOLDING ORNAMENTAL LAMP POSTS

Methods pursued by a Pacific coast foundry in the production of cast iron posts---Special flask for this job

BY H. COLE ESTEP

IT IS the purpose of this article to tell how a general jobbing foundry solved the problem of casting 250 ornamental cast iron lamp posts in an economical manner. The posts were cast by the Olympic Foundry Co., Seattle, Wash., as part of an order from the City of Seattle for about 375 posts. The posts weigh about 550 pounds each and the average thickness of metal is ½-inch. The pole is 11 feet, 6 inches in length to the bottom of the lower cross arm; the base is 18 inches square and the large diameter of the shank is 6 inches. Evidently the post could not be cast in one piece. On account of shrinkage strains some doubt might be felt of the advisability of casting the base and shank together, but it was finally decided to cast the post in this manner and to depend on a proper pouring temperature and careful gating to avoid these strains. Accordingly, the post was divided into three parts for casting: the base and shank terminating in a dowel at the upper end constituting the first part, the cross arms the second part and the pinnacle arm the third part. The base and shank presented the most difficult problems. The cross arms and pinnacle were easily molded by hand and cast in an ordinary two-part flask.

Division of the Pattern.

The first thing to decide in casting the base and shank was how to divide the pattern. Should the post be molded as shown at A, Fig. 3, or diagonally as at B? Molding it squarely as at A would take less sand and not require as deep a flask as to mold it diagonally, but if molded in the former manner it would be difficult to draw the pattern and would necessitate very thick metal at the corners. So it was decided to mold the post as shown at B, Fig. 3, and to divide the pattern diagonally.

Each half of the pattern was divided into five parts: the main shank and base forming one, to which was doweled the ornamental decorations at the top of the pole, the removable panel in the base and the lower corner shown at M, Fig. 3. These doweled pieces remained in the sand when the main pattern was drawn and were drawn separately.

Special Flask.

The flask, shown in plan and elevation in Fig. 4, was made specially for the job. Two flasks were made and two posts were cast daily. Since the work was more or less temporary a plain wooden flask was built. A combination wood and iron flask with iron bars, such as is used by the Independent Foundry, Portland, and described in THE FOUNDRY, April, 1909, page 72, would have been more suitable for this work than the plain wooden flask. The drag of the flask, as built, was made tapering and set on a special, inclined bottom board. This was done to save sand and weight and consequently time. The

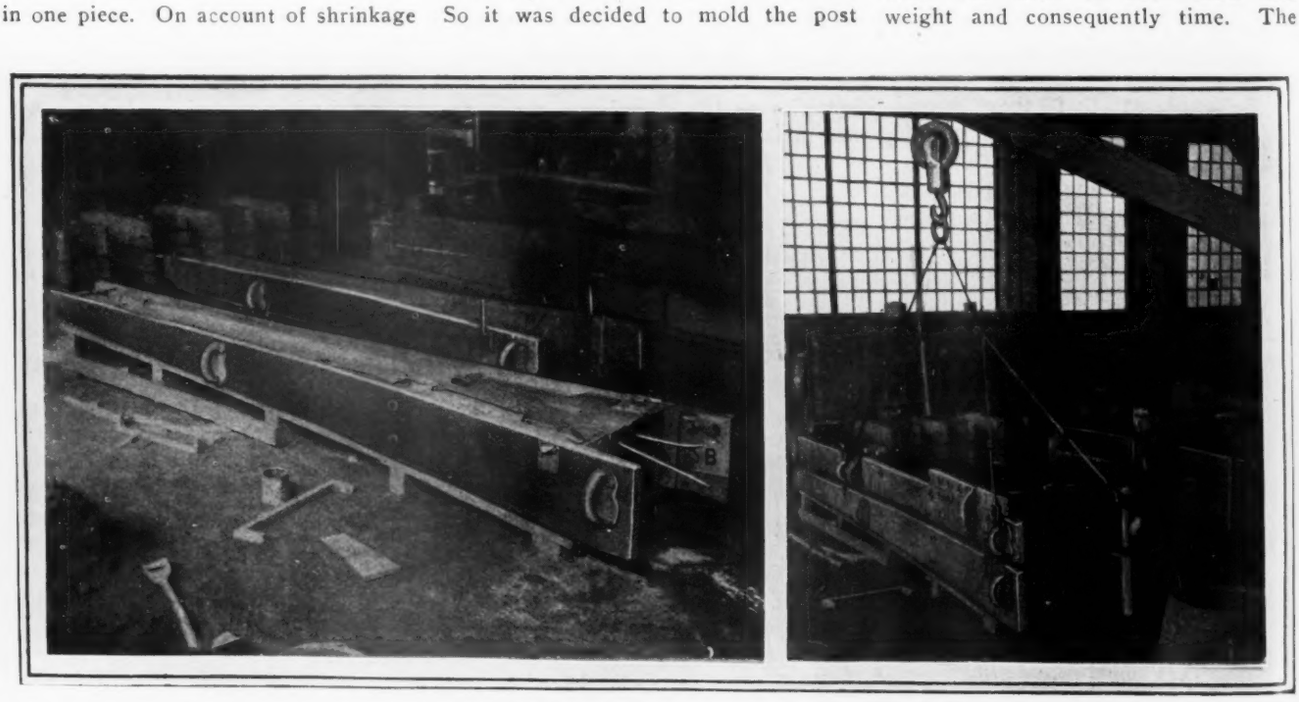


FIG. 1—COPE AND DRAG HALVES OF LAMP POST MOLDS. RODS IN CORES ARE SHOWN AT B

FIG. 2—LIFTING OFF THE COPE WITH A JIB CRANE

sand over the pedestal was supported by iron flask bars; the remainder of the cope was provided with wooden bars.

As is shown in the plan, Fig. 4, there are two runners at the lower end feeding the pedestal, one pouring basin at the upper end and one riser. The riser, shown at R, Fig. 3 and Fig. 4, is situated at the highest point in the casting and is near the runners feeding the base. The pouring basin leads through two runners to a wide gate on each side of the top of the post, the gates being cut in the drag. A detail of these gates is shown in Fig. 5.

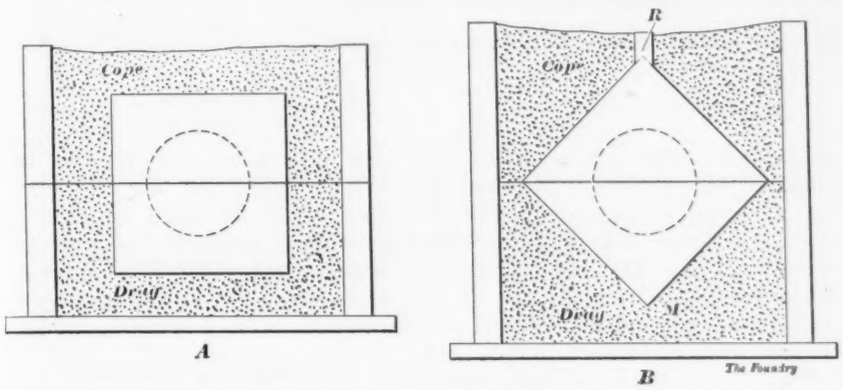


FIG. 3—TWO METHODS OF MOLDING THE BASE OF THE POST. THE DIAGONAL METHOD B, WAS ADOPTED

The molding is done by three men, two molders and a helper. First the drag is rammed by hand and rolled over with the jib crane which is very useful and saves a large amount of labor. It has a capacity of 2 tons and a radius of about 14 feet. With it, one man can handle a flask that would require six men to handle by bodily strength. This crane supplements the main foundry traveling crane, so there is no time lost by the molders waiting for the crane. The jib crane is always ready. After the drag is rolled over and struck off, the cope is set in place and rammed. Then the cope is lifted off by the crane as is shown in Fig. 2. The pattern is drawn by hand from the cope and drag and the molds, lying side by side as shown in Fig. 1, are each finished by one molder.

The core is made in three parts; the stem, pedestal and ornamental scroll at the top of the pole each being set separately. The cores are set by hand. The only heavy one is the pedestal core, which is made to come through the end of the flask so it may be steadied in setting by the two bars shown at B, Fig. 1. The mold is finished with plumbago laid with a camel's hair brush; flour is sprinkled on the pedestal portion of the mold.

The time required by the two molders and helper, aided by the jib crane which is operated by the helper, to make one mold is as follows: Ramming drag, rolling over and striking off, 35 minutes; ramming cope, 40 minutes; taking off cope, drawing pattern from cope and drag and finishing mold, 1 hour and 30 minutes; setting cores and closing mold, 45 minutes; total time to make one mold, 3 hours and 30 minutes. The contract price of the posts was $36 each, complete but without lamps, globes or wiring.

The metal mixture used in casting these posts consists of English No. 1, (Cleveland) gray pig iron and selected railroad cast scrap in the proportions of 60 per cent pig and 40 per cent scrap. The average Pacific coast mixture for gray castings is half pig and half scrap; the lamp post mixture was made a little richer in pig iron. Although the metal was thin, no high phosphorus pig was used. The three runners were poured simultaneously. The metal was melted white hot and poured at a temperature of approximately 2,450 degrees, Fahr.

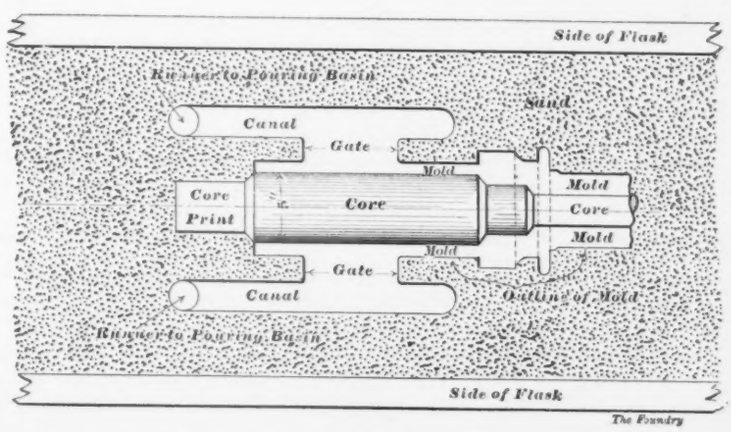


FIG. 5—DETAIL OF GATE AT TOP OF POST

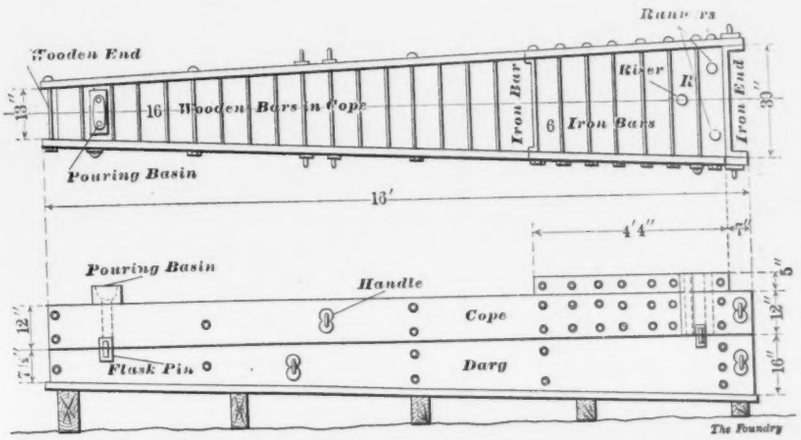


FIG. 4—PLAN OF ELEVATION OF FLASK USED. NOTE THE TAPERING DRAG SUPPORTED BY A SPECIAL BOTTOM BOARD

A bulletin issued by the United States geological survey on the production of tin in 1908, showed that the total output in the United States and its territories consisted of a few tons of stream tin sluiced from the gravels of Seward peninsula in Alaska. The imports of tin amounted to 41,267 short tons, valued at $23,923,560.

A SIMPLE FOUNDRY COST SYSTEM*

A practical and economical method of obtaining costs with a limited amount of clerical labor

BY B. A. FRANKLIN

THE SUBJECT of costs in the foundry has been much discussed, but alas! more popular in the discussion than in the use. Nevertheless, increasing competition is making it a more and more vital subject, even if it be not yet thoroughly believed—what is really the truth—that the use of a good cost system in the foundry is a good profit-maker. The subject is eloquent in practice, but dry, unfortunately, in detailed presentation.

There is—somewhat peculiar to foundry work, if fair profits are to be obtained and unfair competition avoided—another definite reason why costs should become vital in foundry practice. This reason is involved in the fact that in the average foundry there is seldom such a thing from the cost point of view as staple work.

Most manufacturing establishments in some degree, repeat exactly the articles of manufacture and consequently expect to repeat or approximate the same article cost. In foundry work, however, the constant and unproportionate daily variation of size, shape, weight and difficulty of the different castings made, cause such certain variations of cost per pound, the usual unit of selling price, that the different foundrymen bidding on the same job produce, in estimating, figures widely varying, dependent upon their method of estimating as well as their judgment. It would seem that these very variations made it more important that the foundry should have a good cost system. But what if founders had a standard and uniform method of cost keeping? Would it not be to the advantage of all?

*Presented at the Cincinnati convention of the American Foundrymen's Association.

	OCT. 9		OCT. 16		OCT. 23	
	Lbs.	*Amount*	*Lbs.*	*Amount*	*Lbs.*	*Amount*
MIXTURE No. 1						
Pig Grade 1	34240	252.22	33950	253.87	25620	191.58
" " 2	32270	234.10	33290	249.68	25440	187.39
" " 3	5680	38.67	14270	97.15	6010	40.92
" " 4	36310	259.35	32070	232.65	30150	218 72
" " 5	31500	249.61	32720	259.28	25080	198.74
Bought Scrap	15900	106.47	17000	113.84	11900	79.68
Own Scrap Chillers	1275	0	1420	0	1135	0
" " Floor Scrap	7300	0	9000	0	7700	0
" " Bad Castings	10000	70.00	9000	63.00	10000	70.00
" " Gates	36100	0	34800	0	26500	0
Weekly Totals Metal Used	210575	1210.42	217520	1269.47	169535	987.03
Period Totals Metal Used			428095	2479.89	597630	3466.92
Weekly Total Lbs. Castings Made	149280		150441		116451	
Period Total Lbs. Castings Made			299721		416172	
Good Castings Made	140125		139867		109069	
Period Castings Made			279992		389061	
% Good Castings to Melt	66.5%		64.3%		64.3%	
Period % Castings Made					65.1%	
Bad Castings	9155		10574		7382	
% Bad Castings to Castings Made	6.1%		7%		6.3%	
Shop Scrap	51800		54400		43700	
% Shop Scrap						
Total Lbs. (Weekly)	201080		204841		160151	
Total Lbs. (Period)						
Lbs. Lost	9495		12679		9384	
Period Lbs. Lost			22174		31558	
% Lost	4.5%		5.8%		5.5%	
Period % Lost					5.3%	
Weekly Metal Cost per 100 Lbs.		.81	.84		.85	
Period Metal Cost per 100 Lbs.			.83		.83	

FORM 1—WEEKLY FOUNDRY OPERATION COST SHEET, SECTION A

Uniform Cost System.

Such a system must first of all be simple. It must be capable of operation with small clerical labor. It must be understandable to the practical man. And it must present to the foundryman such units of cost along the various elements of manufacture as will permit him to estimate, with some assurance of approximation to the real cost, when his estimate gets the job. What is really vital in a cost system? It should so illustrate and picture the passing situation to the practical man as to bring about reduction of cost.

This paper is presented, therefore, not with the idea of discussing cost system in general, but of presenting a method of cost system in particular, now in successful operation in several foundries, which can be operated in almost any foundry with one clerk, and, of value in a right cost system, a method which will not only give the cost of a particular order or casting, but will so show the variation of the elements of manufacture as to help in obtaining the lowest cost of operation under the hand of a good foundryman and manager.

Division of Operations.

The operations are divided into the elements of—

SECTION A.

MELTING:
1.—Metal.
2.—Fuel.
3.—Melting expense.

SECTION B.

MOLDING:
4.—Molding labor.
5.—Molding expense, floor and bench separately.

SECTION C.

6.—Cleaning labor.
7.—Cleaning expense.
8.—Tumbling labor.
9.—Tumbling expense.
10.—Pickling.
11.—Pickling expense.
12.—Sand-blasting labor.
13.—Sand-blasting expense.

	OCT. 9 Amount	OCT. 16 Amount	OCT. 23 Amount
FUEL & MELTING EXPENSE			
Labor (Cupola Men)	45.65	44.70	33.70
" (Handling Coke & Coal)	1.80		
" (Miscellaneous)			
" (Handling Iron)	5.73	18.51	9.22
Coke	53.50	55.97	44.08
Coal	1.82		
Wood			
Fire Brick			
Fire Clay	3.20	.90	8.25
Oyster Shells	1.64	2.00	1.53
Mica Sand	2.63	2.63	2.63
Chg. from Other Depts.			
Analysis of Iron	30.00	30.00	30.00
Relining Cupola & Repairs	2.00		
Tumbling Cupola Bottom	2.90		
Crane Labor	10.95	10.75	9.30
Elevator Labor	8.66	8.52	6.93
Blower Labor	.53	80	.44
Handling Oyster Shells			
Bituminous Facing			
Interest on Investment	10.20	10.20	10.20
Heat, Light & Power	6.15	6.15	6.15
Taxes, Insurance and Depreciation	12.42	12.42	12.42
Weekly Expense	199.78	203.55	174.85
Period Expense		403.33	578.18
Weekly Lbs. Castings Made 149280		150441	116451
Period Lbs. Castings Made		299721	416172
Weekly Cost per 100 Lbs.	.134	.135	.15
Period Cost per 100 Lbs.		135	.139
Weekly Lbs. Melted to Lbs. Fuel	8.7	8.4	8.3
Period Lbs. Melted to Lbs. Fuel		8.5	8.5

FORM 2—FUEL AND MELTING EXPENSE SHEET, SECTION A

SECTION D.

14.—Core labor.
15.—Core expense.

SECTION E.

16.—General expense.

In discussing this system no attempt is made to discuss the method of getting the information because such methods are simple and easily worked out. The basic costs are illustrated in Form 1 which shows the weekly operation of the foundry as a whole, and Form 9 represents the cost of an actual casting. Form 10 represents the monthly foundry showing of profit and loss, offering means of proof of the foundry cost and showing the net result.

A foundry has one advantage from the cost point of view. Its operation may be considered, as in few other plants, as terminating each day. The melting starts in the morning and is over at the end of the day. This is likewise mostly true of the molding, except in case of very large castings. It is on the average true of cleaning, pickling, tumbling, etc. As nearly as possible, foundry shop economy demands, and foundry work permits of a daily clean up, though, of course, some operations happen one day after the beginning.

A foundry cost might then be a daily record sheet. Weekly records, however, are sufficient generally, and the one presented is on this basis.

Note the basic method illustrated in Form 1. Section A deals with metal. Here is shown, separately for each different mixture, of which one foundry might generally employ two or three, the weights and value of iron charged. These weights may readily be proved by checking as each car or lot of scrap is used. In the case of scrap made in the foundry or "own scrap," no value is put on this since it is put into the heat in an iron foundry, on the basis that scrap made on each heat will be approximately the same per cent, and what is made one day is gathered and used the next day. The exception to this is in the case of "bad castings," charged at scrap value, and, as seen later, accounted for in casting cost.

In a steel foundry it would be necessary to charge all scrap at scrap value and credit the same to particular castings.

The "metal-used" value is shown and the pounds melted, but the "metal cost" is obtained by dividing, not by pounds melted, but by pounds of "castings made," in other words, good and bad castings. The bad castings are to be charged to the particular order as will be seen later. We thus arrive at a weekly metal cost for each mixture.

Percentage of Good and Bad Castings.

Likewise, for purposes of general guidance, there is shown weekly the "per cent of good castings to melt,"

	OCT. 9 Amount	OCT. 16 Amount	OCT. 23 Amount
BENCH MOLDING			
Prod. Labor	884.80	858.80	715.40
Period Prod. Labor		1743.60	2459.00
MOLDING EXPENSE ON PROD. LABOR			
N. P Labor	10.00	10.00	5.00
Flasks, Snap Boards & Matches	6.58	6.88	1.15
Miscel. Supplies	2.42	2.80	1.09
Ladles	7.50		
Shovels & Screens	2.60		1.60
Rammers			
Chgs. from Other Depts.	23.16	10.48	
Making Bottom Boards for Mold. Machines		23.54	
Repairing Flasks			8.19
Sand	46.37	50.83	37.77
Handling Sand	6.30	6.88	6.10
Handling Weights & Bands	.47	.40	.62
Reclaiming Sand	2.30		
Parting Sand		1.65	
Interest on Investment	30.58	30.58	30.58
Heat, Light & Power			
Taxes, Insurance and Depreciation	41.94	41.94	41.94
Weekly Expense	192.22	185.98	134.04
Period Expense		387.20	512.24
% Molding Expense to Prod. Labor	21.8	21.7	18.7
Period % Molding Expense to Prod. Labor		21.1	20.8

FORM 3—MOLDING EXPENSE SHEET, SECTION B

	Oct. 9		Oct. 16		Oct. 23	
	Lbs.	*Amount*	*Lbs.*	*Amount*	*Lbs.*	*Amount*
Productive Labor		74.62		70.92		57.14
No. Lbs. Cleaned & Tumbled	134462		139089		105203	
Period Lbs. Cleaned & Tumbled			273551		378754	
Cost per 100 Lbs. (if day work)		.056		.053		.054
Period Cot per 100 Lbs. (if day work)				.054		.053
CLEANING & TUMBLING EXPENSE						
Supplies						
Overseeing		2.45		.40		1.93
N. P. Labor				.40		.75
Chg. from Other Depts.				.65		2.02
Tumblers				4.00		
Stars for Tumbling						10.00
Interest on Investment		5.44		5.44		5.44
Heat, Light & Power		55.44		55.44		55.44
Taxes, Insurance & Depreciation		8.40		8.40		8.40
Weekly Gross Expense		71.73		74.73		73.98
Stars Used in No. 3						
Weekly Expense		71.73		74.73		73.98
Period Expense				146.46		220.44
Weekly Expense Cost per 100 Lbs.		.053		.053		.07
Period Expense Cost per 100 Lbs.				.053		.058
Weekly Total Cleaning & Tumbling Cost		.109		.106		.124
Period Total Cleaning & Tumbling Cost				.107		.111

FORM 4—CLEANING AND TUMBLING EXPENSE SHEET, SECTION C

the "per cent of bad castings to castings made," and the per cent of metal disappearance or "per cent of loss."

Now, for management guidance toward general shop economy, these figures present standards and bases for striving for lower costs—viz.: to make the percentage of good castings to the melt as high as possible, to make the percentage of bad castings to castings made as low as possible, and the record will quickly show that the cost fluctuates with these conditions; and it will be found that melting and handling of metal and fuel can be done on piece work to bring best economy in metal cost.

Period Cost Per Pound.

A definite and valuable point to note is that in addition to the weekly figure of cost per pound, there is carried along the average or "period cost per pound." This is the figure to be used in cost work. The periods may be taken over any time desired, ordinarily times of no radical changes.

But there is a very vital value to be noted here. The weekly figures are constantly compared with the period figures showing whether the weekly result is better or worse than the average, and an observation of the detail shows why. It will be found that this valuable comparison carries through the whole method.

It will be likewise observed that throughout the costs the weekly records, set down side by side, offer easy comparisons and the real life and use of costs comes through comparisons.

In each section, it will be noted, that the costs are brought down to a few vital units or percentages, and when these vary, they are significant of a gain or loss in economy of production, the reason for which can be readily observed by casting the eye up the details and observing the comparison. Here is really the vital feature in this method. And these points are to be observed throughout.

Section B, Molding.

Here are two elements to be considered—productive labor and expense. The expense is shown in relation to productive labor. It may be shown in relation to hours if desired, but in each class of molding labor there is generally no great fluctuation of rate per hour, and it is attempted here to show the simplest and most economical method, clerically.

The productive labor and expense should be kept separately as to class of molding, as floor, bench, machine, etc., since the expense varies considerably with the class.

There may arise here some question as to whether expense should be shown by the pound or productive labor. There is, unfortunately, no absolute way of loading on expense which will withstand all arguments, but a little thought and experiment would seem to show that on the whole, the expenses approximately vary according to time spent in productive labor rather than by the pound.

In the matter of productive labor it is to be understood that money paid for molding each job, whether day work or piece work, is to be known and used in figuring definite casting, as shown in Form 9.

It is in this productive labor cost that the first element of variation in casting costs is to be found, the expense percentage being the same or taken as the same, except in the matter of certain direct charges or expenses to be discussed later. Note

	Oct. 9		Oct. 16		Oct. 23	
	Lbs.	*Amount*	*Lbs.*	*Amount*	*Lbs.*	*Amount*
Weekly Prod. Labor		20.70		19.82		13.10
Period Prod. Labor				40.52		53.62
Weekly Lbs. Pickled	62818		65600		36220	
Period Lbs. Pickled			128418		164638	
Weekly Cost per 100 Lbs. (if day work)		.033		.030		.036
Period Cost per 100 Lbs. (if day work)				.032		.034
PICKLING EXPENSE						
N. P. Labor		1.75		.75		1.10
Oil of Vitrol		2.06				
H. F. Acid		23.92		15.28		10.51
Acid Spigots						
Chg. from Other Depts.				1.88		1.48
Interest on Investment		3.40		3.40		3.40
Heat, Light & Power		3.08		3.08		3.08
Taxes, Insurance & Depreciation		2.53		2.53		2.53
Total Weekly Expense		36.74		26.92		22.10
Total Period Expense				63.66		85.76
% Dept. Expense to Prod		177.5%		135.8%		168.7%
Period % Dept. Expense to Prod. Labor				155.8%		160%

FORM 5—PICKLING EXPENSE SHEET, SECTION C

again here the weekly and period comparison.

As to shop economy, I would say that piece work on all molding and a watchfulness of the percentage of expense and direct charges will bring the best shop practice.

And note that the detail of expense is so given as to permit quick and sensible criticism.

Section C, Cleaning Castings.

In the matter of cleaning castings there must be some division—tumbling, pickling and sand-blasting are taken separately as shown below. This leaves for consideration here the cleaning of castings by other than these three methods and applies mainly to large castings, the smaller ones being generally handled by one or two of the above three methods. In the case shown, no data are given for cleaning large castings, but the method is as shown in tumbling, etc.

The productive labor for economy's sake can invariably be put on piece work, though perhaps not individual piece work, and the expenses, generally small in comparison, will be shown on the pound basis, although where confined to strictly large castings would be more truly shown in relation to productive labor, and labor in this case is almost evenly indicative of time.

In tumbling, the labor can best be put on piece work and will generally be done by the pound, and expenses will be shown by the pound. The case shown gives cleaning and tumbling together, since it considers only small castings. It may be said that the figures given are not intended to be exactly correct, but are merely illustrative.

In sand-blasting and pickling the expenses are shown in relation to productive labor, and the work can be put on piece work.

As in the other sections the detail, the weekly and period showings are presented—really pictures of the situation.

Section D, Core Room.

Here the labor can in the main be put on piece work and the expenses shown in detail. In relation to the labor by weekly and period percentages, the labor cost of cores on castings is to be obtained by the usual method.

	OCT. 9		OCT. 16		OCT. 23	
	Lbs.	*Amount*	*Lbs.*	*Amount*	*Lbs.*	*Amount*
Productive Labor		233.55		220.65		165.65
Period Prod. Labor				454.20		619.85
COREMAKING EXPENSE						
Foreman		24.00		24.00		24.00
Tending Ovens		12.65		12.63		7.87
Inspecting Cores		19.14		18.08		13.89
Storing Cores		12.10		11.78		9.62
General Labor		17.11		15.16		13.37
Sand		21.80		18.32		25.89
Coke		2.92		2.45		1.56
Coal		6.44		5.58		1 73
Rosin						
Miscel. Supplies		5.54		3.00		1 55
Flour						
Interest on Investment		13.67		13.67		13.67
Heat, Light & Power		1.43		1.43		1.43
Taxes, Insurance & Depreciation		21.61		21.61		21.61
Weekly Coremaking Expense		158.41		147.71		136.19
Period Coremaking Expense				306.12		442.31
Weekly % Expense to Prod. Labor		67.8%		66.9%		82.8
Period % Expense to Prod. Labor				67.4%		71.3..
Labor				67.4		71.3%

FORM 7—CORE DEPARTMENT EXPENSE SHEET, SECTION D

	OCT. 9		OCT. 16		OCT. 23	
	Lbs.	*Amount*	*Lbs.*	*Amount*	*Lbs.*	*Amount*
Weekly Prod. Labor		4.37		6.06		4.61
Period Prod. Labor				10.43		15.04
Weekly Lbs. Sanddblasted	10200		11800		8100	
Period Lbs. Sandblasted			22000		30100	
Weekly Cost Per 100 Lbs. (if day work)		.043		.051		.057
Period Cost per 100 Lbs. (if day work)				.048		.05
SANDBLASTING EXPENSE						
N. P. Labor				.61		.41
Supplies		.75				
Sand		1.10		1.10		1.10
Chg. from Other Depts.						
Interest on Investment		6.80		6.80		6.80
Heat, Light & Power		15.40		15.40		15.40
Taxes, Insurance & Depreciation		1.38		1.38		1.38
Total Weekly Expense		25.43		25.29		25.09
Total Period Expense				50.72		75.81
% Dept. Expense to Prod. Labor		581.9%		417.4%		544.2%
Period % Dept. Expense to Prod. Labor				486.3%		504.2..
Prod. Labor				486.3		504.2%

FORM 6—SAND-BLASTING EXPENSE SHEET, SECTION C

Section E.

We come finally to general expenses. This is shown in relation to productive labor, the item of productive labor being those of molding, core making and cleaning operations.

It may be well to say again that the expenses shown here, and the names by which they are denominated, must not be considered significant. These are simply the way they occurred in a particular foundry. They may be differently denominated and detailed in another foundry, and are merely considered to be illustrative of the method.

Thus we arrive at certain weekly and period basic figures of cost in the main elements in the foundry of metal, molding, cleaning, core making and general expenses.

The items of metal and expense are easily provable with the books monthly, and the labor with the pay roll weekly, so that we get a proved weekly picture of the foundry situation as compared with average or period, and we get it in such detail as will show the reasons of all variations of operation, which showing, in at least four cases where the system is in operation, has brought about definite economies and reduction of cost.

We now come to the consideration of casting cost. The first element

	OCT. 9 *Amount*	OCT. 16 *Amount*	OCT. 23 *Amount*
Executive	27.00	27.00	27.00
Foreman	48.00	48.00	48.00
9396—2—B			
N.P. Labor	12.74	25.08	16.67
Clerical	49.00	49.00	49.00
Supplies	.87	1.43	1.85
Chg. from Other Depts.	15.55	26.00	27.75
Scrap	45.38	3.57	13.98
Gas	1.00	1.00	1.00
Inspecting	63.20	64.59	42.65
Injured Employee			5.00
Tending Pattern Safe	11.47	9.60	7.20
Brooms			.75
Interest on Investment	11.56	11.56	11.56
Heat, Light & Power	22.59	22.59	22.59
Taxes, Insurance & Depreciation	310.45	310.45	310.45
Weekly General Expense	618.81	599.87	585.45
Period General Expense		1218.68	1804.13
Weekly Prod. Labor	984.49	955.60	790.25
Period Prod. Labor		1940.09	2730.34
% Expense to Prod. Labor	62.9..	62.8..	73.9
o Expense to Prod. Labor	62.9%	62.8..	73.9
. o Expense to Prod. Labor	62.9	62.8%	73.9
..o Expense to Prod. Labor	62.9	62.8	73.9%
Period % Expense to Prod. Labor		62.8%	65.8%

FORM 8—GENERAL EXPENSE, SECTION E

to consider is that of direct charges. On many jobs, but by no means all of them, are certain charges which it seems desirable should be charged directly to the particular order. They need in most foundry work be very small in number. These charges must essentially be gathered and held until the job is shipped and cost ready to work out. Form 9 illustrates this final casting cost.

In all castings finished in a given period, the varying elements of unit cost would be purely the productive labor items of molding and cleaning and direct charges, the metal, fuel, melting, molding, cleaning and general expense charges being taken from the period figures on the weekly cost sheet.

Therefore, in working out the cost of a finished casting, it is essential to know of it as a particular job, the weight, the molding and core making labor and the cleaning labor, where average rates per pound are not used.

The basic form furnishes the other figures of cost, and it will be seen that it is on this basis the particular costs shown are worked out. Direct charges are added and also loss on bad castings. A record of bad castings is necessary and simple.

On bad castings the loss would depend on how far the work had progressed when discovered as bad, and what work on them had been paid for.

Date, Oct. 12
150 Blocks—J. & S. Co.—850 Lbs.

	Amount	*Unit Cost*	*Value*	
Metal	850	.83 per 100	7.05	
Melting Expense		.139 per 100	1.18	
Molding			3.00	
Molding Expense		20.8%	.62	
Cores			.50	
Cores, Expense		71.3%	.36	
Cleaning & Tumbling		.053 per 100 Lbs.	.45	
Cleaning & Tumbling Expense		.058 per 100 Lbs.	.49	
Sandblasting				
Sandblasting Expense				
Pickling		.034	.29	
Pickling Expense		160%	.46	
General Expense		65.8%	2.13	
Spoiled Work			.42	3 spoiled
Total			16.95	
Cost per Lb.			.0199	

Note.—In this case no selling expense is added, as it might be in many cases.

FORM 9—INDIVIDUAL JOB OR CASTING COST

The metal, of course, would be credited at scrap value.

By this method then it will be observed that with very small clerical labor the practical foundryman or manager gets a weekly, or daily, if he so desires, view of his foundry costs and their fluctuations which forms a definite and correct basis for accurate estimate, and he can very quickly get a particular job or casting cost by having the outlay on molding and cleaning, etc., classified.

The cost system settled, the bookkeeping should be made to parallel the cost system, in which case the monthly showing would be made to conform to Form 10.

Quick Assets.
Cash
Accounts Receivable
Permanent Assets.
Real Estate
Building
Machinery
Raw Material on Hand.
Pig Iron (Credit amount used each week as per costs and charge to Mfg. Acct.)
Scrap
Manufacturing Acct. (See analysis below)
Expenses undivided (Meaning expense supplies not used)
Quick Liabilities.
Accts. Payable
Permanent Liabilities.
Capital
Depreciation
Surplus

Detail of Mfg. Acct.
Dr.
Inventory at start of Castings in process
Metal } each month
Labor }
Expense }
Cr.
Sales
Inventory of castings in process 1st of each month.
Balance Profit or Loss monthly.

FORM 10—MONTHLY PROFIT AND LOSS SHEET

Thus is obtained a complete monthly analysis. In most foundries one clerk, and almost invariably two, can operate the system as far as costs are concerned.

The method of considering certain details may be disputed and still not alter the practical operation of the system, which, as has been said, is in successful operation in several foundries.

Thus is shown a cost system for the foundry—proved by operation—simple, cheap as to clerical labor, provable as to accuracy, presenting the main facts to the practical man for reduction purposes, giving basic figures for accurate estimate and giving accurate cost of a particular casting.

EUROPEAN AND AMERICAN FOUNDRIES

A comparison of the casting plants of Germany, Belgium, England and Switzerland with those of the United States

BY. W. H. DOOLEY

THE most striking feature of European foundries is their clean, orderly and well-kept condition. This seems to be universal, and applies to the smallest jobbing shops. The German foundries are a revelation to any American. They are as clean and well-kept, and almost as light as any other shop. The remarkable order maintained is systematic, and in a large measure intended to promote the prevention of accidents. In the accident prevention rules of the Rhine-Westphalian Engineering and Small Iron Industries Association, I find it laid down in the first paragraph that:

The gangways in all workrooms must be broad enough to exclude as far as possible injury to persons using them, by machinery or transmission parts in motion. They must be kept in good condition, and must not be blocked by the heaping of material or the transportation of articles.

That is exactly what happens in many of the American foundries. There is no room, the places are congested, and manufactured or half manufactured articles lie promiscuously about, blocking the passage-ways. The entire freedom from such disorderliness in German foundries undoubtedly conduces to efficiency as well as to safety, and it is secured chiefly through the habits of order inculcated into all alike—workmen, managers and owners—by the military discipline they have all undergone.

Diversity of Work.

The European foundries attempt to do a great many lines of work. This is due to the fact that the machine shops and engineering plants attached to the foundries are turning out more varied lines of tools than the American foundries and engineering works. The result is that the American manufacturer, who specializes, can turn out castings cheaper than the European manufacturer. There is another advantage which the American manufacturer has over the European, and that is shop efficiency. Foreign manufacturers are not economical in manual labor. They have not the thousand and one devices we have for doing away with manual labor.

Krupp Foundry.

In order to make a comparison as regards the workshop, the writer will give a description of the Krupp foundry in Essen, where a specialty is made of casting large ingots of crucible steel. It is a remarkable sight and an object lesson in German methods. Ingots of 85 tons are cast, a feat which is, I believe, not attempted elsewhere.

The steel is melted in small crucibles which are carried by hand, and therefore contain not more than two men can lift. Scores of such crucibles go to the making of an ingot of considerable size, and they occupy many furnaces which are ranged on both sides of the foundry with the ingot mold in the middle. At a signal, the furnaces are opened and the crucibles are drawn out and seized by a small army of men, who run them down to the mold and pour in the molten steel. It is clear that to do the thing on a large scale perfect method in preparation and order in execution is necessary. The maneuver is carried out with military precision and promptness. In a moment the place is aglow with the white heat of the furnaces; the figures run from all sides and come staggering down in pairs with pots full of liquid steel. It is a scene of intense activity, but without confusion. One after another, the glowing pots are emptied. In a few minutes it is all over; the furnaces are closed again, the used crucibles are thrown aside, and the cast mass begins to congeal and change color.

The steel so made is the purest known, close-grained, homogeneous and uniform throughout. They say it is not made in America, where the impatience of hand process, which is characteristic, and has led to such remarkable developments of automatic machinery, has its weak side.

The Germans are great imitators. They are building up-to-date foundries with all mechanical devices. The most recently built workshops at Krupp are quite modern in their construction—light, spacious and airy—but they are in no way superior to the newer foundries in England, especially at Sheffield, which are well equipped with modern appliances, such as electric cranes and hydraulic molding machines.

Foreign countries recognize the duty and exercise the right of regulating factories in the interest of the employed; but in doing so they are careful to keep in view the equal duty of fostering national industries, and consequently their laws in many respects are much less stringent than the American.

Laws Governing Child Labor.

The most stringent regulations in the foundries of Germany are those affecting children, and herein the state clearly has in view the interests of the community as represented by the employed. In the year 1901 there were only 9,454 children under 14 years of age at work, and 11.5 per cent (chiefly boys) were employed in the metal trades. Every foundry must have a set of rules hung up in an accessible place in each department, stating the hours of work, with the regular intervals for meals, the time and manner of paying wages, the length of notice required for terminating employment and conditions which render notice unnecessary, and particulars of punishment, including fines and the objects to which they will be applied. The factory rules are legally binding on employers and employes, but before they are issued opportunity must be given to adult workers to express their views, and the rules, with any written objections, must be submitted within three days of issue to the factory inspector, who may order amendments if the rules are not in accordance with the law or with the special regulations.

Before any foundry can be started, it is necessary to give notice to the local authority and special permission must be obtained. Owners are bound to arrange their plants so as to have sufficient light, ample air space and ventilation to insure removal of dust, vapors and gases, and ample protection against fire must be provided.

The workmen of European foundries

are good, steady, regular and trustworthy. It is not an uncommon occurrence for the molders in German shops to work on an engineering order from England and use the original drawing with the English measure. Would, or could our American mechanics do the same? The workmen rarely make suggestions, nor is there any system of encouraging them to do so, but they adhere strictly to the rules and do not shirk. In Germany particularly, the workmen do what they are told and do it well. Partly to this can be attributed Germany's industrial activity.

Working Hours.

Roughly speaking the working hours are 10 a day. In the engineering works at Dusseldorf the hours are as follows:

	A. M.
Begin work	6:30
Breakfast	8:15 to 8:30
	P. M.
Dinner	12:00 to 1:30
Tea	4:15 to 4:30
Close	6:30

Total, 12 hours, minus 2 hours for meals, equals 10 hours; week 60 hours.

Working hours in the machinery works at Dusseldorf:

	A. M.
Begin work	7:00
	P. M.
Dinner	12:00 to 1:30
Close	6:30

Total, 11½ hours, minus 1½ hours for meals, equals 10 hours; week 60 hours.

Hours in steel works at Essen (Krupp):

	A. M.
Begin work	9:00
Breakfast	8:00 to 8:15
	P. M.
Dinner	12:00 to 1:30
Tea	4:00 to 4:15
Close	6:00

Total, 12 hours, minus 2 hours for meals, equals 10 hours; week, 60 hours.

One cannot help but take note of the amount of time required for meals in foreign countries, particularly in Germany. It is the characteristic of the German, as indifference to meals and hurry are of the United States.

The German employers consider their work people one of the greatest advantages they possess over British and American competitors, not necessarily in skill, but in conduct.

The Germans are copying our shop organization. In fact, we have not been giving the Germans credit for learning how to operate the greatest number of tools with the least number of men. The German foundrymen are learning fast, and if we propose to keep ahead in shop efficiency, and in our ability to run a shop with the least number of men, we must look to the training of our workmen from boyhood up. There is a well founded belief that the loss of English trade in machine tools has been due to this very lack of technical training.

Foreign countries, especially the continental nations of Europe, recognized the need of industrial education long ago. In every community in Europe where the metal trade is the leading industry, one finds various kinds of technical schools, each satisfying a particular educational need of the metal workers. There is no nation in the world that gives greater encouragement and opportunity to its people to become skilled artisans than Germany. Municipal, state and federal governments, all contribute to the establishment and support of technical and industrial schools, and there is scarcely a city or town of any importance where one of these splendid institutions is not found. They cover the whole educational period. There are the lower industrial schools which connect directly with the elementary schools and thus become continuation schools, and give training to apprentices and workmen in the metal trades. There are the higher industrial schools which correspond to our technical colleges and produce the leading experts on iron and steel; and there are the middle industrial schools for workmen who have gone through the lower industrial schools, but who desire further education in foundry work, and may wish to prepare themselves to become upper foremen or assistant foundry superintendents.

Courses of Instruction.

The instruction in the lower industrial schools is given in the evening and on Sunday. Attendance is compulsory for apprentices in foundry and machine shop work. The weekly period of instruction is nine hours, of which three are on Sunday morning, from 9 to 12, and three hours each on two working days, from 9 to 12 in the morning, or from 4 to 7 in the afternoon. By the arrangement of hours, as well as in the assignment of the individual class to different week days, is rendered possible a suitable change in school attendance in the interest of the workshop management.

A list of classes and the number of hours devoted to each study, are given below:

	Hours of Instruction. Class I.	Class II.	Class III.	Class IV.
Religion	1	1	1	..
Trade calculations and bookkeeping	1	1	1	1
Business composition and reading	1	1	1	..
Studies of life and citizenship	1	1	1	1
Mechanical drawing	3	3	3	3
Physics and mechanics	2	1	1	2
Machinery	..	..	1	2
Material and shop	..	..	1	2
	9	8	10	11

The instruction in physics and machinery, as well as in materials and shop work, is undertaken by a skilled machinist who is a foundryman as well. The remaining instruction is imparted by the appropriate teachers of the common and continuation schools.

There is a school of metallurgy at Duisburg, Prussia. The object of this school is to prepare foremen for smelting works, rolling mills, and to educate draftsmen for these industries. The scope of the education offered is limited to that necessary to prepare foremen and employes holding unimportant executive positions. The instruction is essentially theoretical. There is no opportunity, except in drawing, for the student to do any practical work. The school does not even possess a chemical or physical laboratory. The reason for this is that students are required to have had at least four years' experience in the foundry trade before they are admitted. The need of the pupil is, therefore, theoretical instruction to supplement his workshop experience. The course requires the whole time of the student for two years. This feature of the school has been criticized on the ground that the length of time required deprives many from availing themselves of its advantages, and it has been suggested that by cutting out the elementary work in language, arithmetic, penmanship and similar subjects, the time could be reduced one-half. This suggestion, however, ignores the general principle underlying the whole German educational system, that, as far as possible, a well rounded education must be striven for and the state aims always to qualify the pupil for civic as well as industrial life.

Industrial Education in Switzerland.

The Swiss take great interest in industrial education. One of the most far-reaching legislative acts relating to the education of the workman, particularly in the metal trades, was that of the apprentice school law which was passed by an overwhelming majority of the people by a referendum vote in 1906. This law compels every employer of labor who seeks to teach a trade, or accept boys or girls as apprentices, to allow a certain number of hours a week, during the day, for attendance at industrial schools. In this way Switzerland has assumed a firm and absolute control of the apprenticeship system.

France has an excellent system of technical schools for wood and metal-working, at Paris. These schools have

sprung up in response to the special local needs of the community.

Industrial Education in England.

England, while trailing some of the continental nations in technical and industrial education, in the metal trades, is now rapidly forging to the front. The new university at Birmingham is well equipped throughout and its metallurgical department takes rank with the world's best scientific schools.

The hours of labor, while less in England than on the continent, usually begin so early in the morning, that is, about 6 o'clock, with an intermission for breakfast, that the apprentices and younger workmen are too tired when the time for evening school arrives, to give close application to the mathematical and other branches. Many attempts have been made to get employers to let off the students of the evening school, if under 21, at an earlier hour, or let them work later in the day. This has been done in a few cases, but not to as large an extent throughout the country as is desired.

The metal labor unions of England look with favor on schools that maintain night classes for the purpose of giving theoretical and technical instruction in trade work, and these are considered by the representative leaders of these trades to be valuable to the workmen. A number of unions give such schools their moral support, and some offer special inducements to encourage the attendance of members and their sons.

Belgium.

In Belgium, employers of foundries prefer workmen who have a trade school education. The secretary of the Metal Workers' Union of Ghent said that a school training can replace that of the shop to a large extent, especially in forge work, although it cannot do so entirely. Proof of any great difference between the results of employing the shop and the school trained workman has not as yet been produced, but there is less trouble in starting the trade school graduate to work than there is with the so-called apprentice.

According to the secretary, the man who has a trade school education can more readily obtain employment and advance more rapidly than one who has not. He stated there were 602 technical, industrial and trade schools and courses aided by the government grants and subject to government inspection, with an enrollment of 53,959 pupils and 3,228 teachers in Belgium. All these schools are inspected regularly. In the foundry courses, practical work is the basis of the course in each case. Considerable stress is laid upon mechanical drawing. Both day and evening sessions are held.

The best organized school for metal workers is at Ghent. The aim of the school is to prepare men working in the metal trades for higher positions. The industrial and technical schools for metal workers of Belgium are patterned after the French schools rather than after those of Germany, but in government they more nearly resemble the English schools.

THE PRODUCTION OF PATTERNS FOR LIGHT CASTINGS*

BY W. H. SHERBURN

THE general term "light castings" covers a very wide range, and, therefore, we shall confine our consideration of this subject to one metal and to one branch which I will term the domestic branch. This deals largely with the fireplace and its furnishings. The range of patterns is wide and varies from the simplest flat plate, which a shop boy can make, to the most elaborately modeled design. Just as the artistic finish of the pattern has so wide a range, so do the materials and methods by which they are produced. Wood, for all the plainer patterns, is generally the material used, but for the patterns to which I refer, wood takes a secondary position, except as a backing and boarding for the pattern made in other materials.

In producing this work we must have not only co-operation, but sympathy between the designer, patternmaker and molder. The molder should have a wide knowledge of molding methods and should know something about patternmaking. The patternmaker should have a knowledge of molding methods and the action of metals in cooling. He should also know something about design and ornamentation. I am giving the patternmaker a rather high mark to aim at, but he should attempt it. The designer must keep in view the essential purpose of the pattern he is designing. He should know the best form in which it can be made without destroying its usefulness in any way. He must know all about designing, a great deal about patternmaking and should have some knowledge of molding.

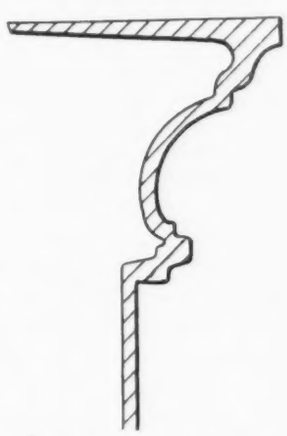


FIG. 1—SECTION OF CAST IRON FRIEZE, SHOWING INEQUALITIES OF METAL THICKNESSES

Unfortunately this is not frequently obtained in the light castings trade. Very often the designs have been purchased from an artist who has known practically nothing of the technicality of cast iron. The designer naturally objects to the patternmaker taking liberties with his work, but unfortunately they must frequently be changed before they can be reproduced.

Occasionally, a frieze, shown in Fig. 1, will be received from the designer. This is an extremely difficult section to cast straight and the designer, without a knowledge of practical work, will occasionally provide for right angle edges and deep sections. Unless modified by the patternmaker, trouble will follow in the foundry. The outer edge will cool rapidly, while the heavy section will retain its heat and strains will result.

*From a paper presented at the Birmingham Convention of the British Foundrymen's Association.

In constructing a panel, the designer will occasionally furnish a section similar to the one shown in Fig. 2. Such a pattern will have to be cast

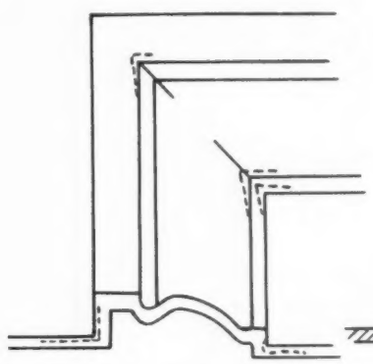


FIG. 2—CORNER OF CAST IRON PANEL MOLDING SHOWING THE EFFECT OF REPEATED CASTING. THREE SHRINKAGES—ORIGINAL PATTERN, PATTERN PLATE AND CASTING

three times to secure the master pattern, a working pattern or plate and ultimately the casting. Plate molding exaggerates all the difficulties in regard to bends, twists and shrinkage. A square mitre or a right angle, in casting iron, is a point of weakness. The design begins to lose its form at the mitres in the direction shown in Fig. 2, and when ultimately the casting is obtained from the plate, the mitres sink and lose their shape. The designer should have filled the inner angles of his panel without necessarily losing any of the artistic effect. This suggested change in position is shown in Fig. 3.

A mantel shelf edge is shown in Fig. 4, and to make this casting in one piece it would be necessary to have a heavy edge on a light plate, as shown at A, and what would transpire if it were made in this way would not be difficult to imagine. A more satisfactory method of constructing this pattern would necessitate the production of two castings instead of one, the top plate forming part of the edge and the bottom plate the other half.

If the pattern is highly ornamented the designer makes his model in clay and from this he casts a mold in plaster and usually overlays the plaster mold with a thickness of clay equal to the thickness of the finished casting. The back mold is then cast in plaster and when set the molds are separated, the clay removed and the intervening space is filled with wax. From this wax model a casting can be made in soft metal which is then cleaned and chased which is used as a master pattern.

Methods differ greatly in different districts. There used to be a Scotch method and an English method of patternmaking, each of them, of

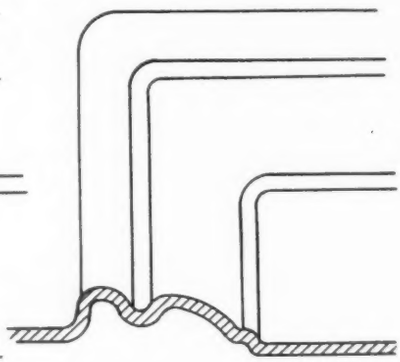


FIG. 3—CORNER OF PANEL PROPERLY DESIGNED

course, being the best. The English method is what we may call "the more artistic" method. The Scotch we may call the "scientific" method. Scottish patternmakers always paid great attention to their lines and the uniformity of their thicknesses. The English patternmakers looked more to the artistic and were very proud of their work from an artistic standpoint. Both of these methods are correct to an extent, but during the last few years there has been a blending of these two, to the advantage of both.

THE PRODUCTION OF MALLEABLE CAST IRON.

By G. B. WATERHOUSE

The intricate chemical and physical reactions involved in the production of malleable cast iron are by no means thoroughly understood. This is especially the case with the process as

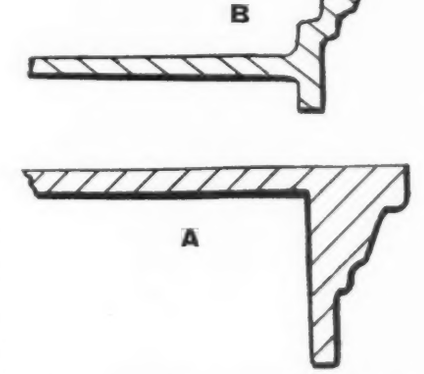


FIG. 4—CAST IRON MANTEL SHELVES—GOOD AND BAD DESIGNS

carried out in Great Britain and Germany, where the condition of the carbon is not only changed from the combined to the free state, but a great deal of it is removed from the metal. The removal of the carbon is effected by the material in which the castings are packed, the temperature of annealing, and the length of the operation.

It is the opinion of several of the well known German metallurgists that before any carbon is removed from the metal, it is first precipitated in the form of the free or temper carbon. It is this temper carbon that gives the well known appearance to American or black heart malleable. To test this theory, W. H. Hatfield of Sheffield has carried out some experiments with very interesting results, which were communicated to the May meeting of the Iron & Steel Institute.

Action of Carbon.

In the first series of tests, three bars were taken of what are known as converted bars. They were identical in composition, and contained:

	Per Cent
Total carbon	1.64
Combined carbon	1.64
Silicon	0.03
Manganese	Trace
Sulphur	0.01
Phosphorus	0.01

They were, therefore, almost pure iron and carbon alloys and contained no free or temper carbon. One bar was packed in charcoal, the second in pure quartz sand, and the third in a red hematite ore mixture, two parts old and one part new. The pots were placed close together in the annealing oven, and slowly raised to about 890 degrees Cent. This required about three days. They were held at this temperature for 24 hours, then raised to 960 degrees Cent., held there for two days, and cooled slowly.

The bars were removed, broken over an anvil and examined with the following results: The first one, from the charcoal, broke short and gave a coarsely crystalline structure. Under the microscope it showed absolutely no free carbon. Its carbon was 1.63 per cent, the other elements being unchanged. The next sample from the sand was fairly tough, but broke without bending. It had a crystalline, steely fracture. Its carbon was 0.74 per cent and again no free carbon was to be found. Evidently the oxygen between the sand grains, and the oxidizing gasses of the furnaces, removed the carbon. Lastly, the bar from the ore mixture bent considerably before breaking, and was fair-

ly ductile. Its carbon was 0.15 per cent and again no free carbon could be found, the structure being of ferrite crystals.

The experiments appear to conclusively prove the possibility of carbon being removed without previous formation of free or temper carbon.

Second Series of Experiments.

For the second series of experiments an ordinary white iron was taken containing:

	Per cent.
Combined carbon	3.5
Free carbon	None
Silicon	0.50
Manganese	Trace
Sulphur	0.35
Phosphorus	0.05

Samples were given the heat treatments shown in the accompanying illustration, and were taken out at the points shown on the curve and cooled rapidly in the air. The packing was the ore mixture previously referred to. Sections were prepared and carefully examined under the microscope.

At the point A, decarburization had commenced, there being a thin skin of ferrite. The remaining portion of the casting retained the typical structure of white iron. This continued up to point D, the decarburized skin increasing in thickness; at D it had penetrated at least 3/16 of an inch. At E, the interior had broken down, and free or temper carbon was apparent. The samples from F to I showed very little difference. The center showed pearlite with a little cementite and containing temper carbon, merging gradually into the skin of ferrite.

The casting was finally a really good sample of English malleable cast iron, its analysis being:

	Per Cent
Combined carbon	0.65
Temper carbon	1.10
Sulphur	0.35
Phosphorus	0.05

The author's views of the chemical physics involved are that carbon is eliminated while still in combination with the iron. It begins to take place at the comparatively low temperature of 750 degrees Cent., and increases in activity with the temperature until such a temperature is reached that free or temper carbon is precipitated. Previous to this change the interior consists of white iron, with the original quantity of combined carbon.

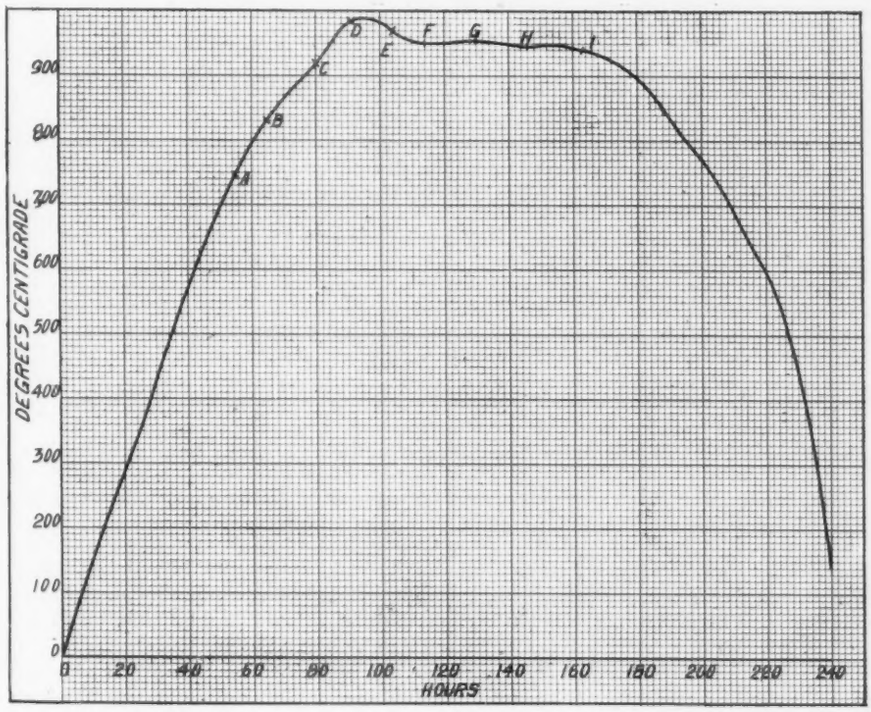
As the operation proceeds, the temper carbon is gradually taken back into combination to replace that removed by the oxidizing influences.

MELTING BEARING METALS.

Question:—We are using a mixture containing copper 77, lead 15 and tin 8, for bearing metal. We use copper wire but the mixture seems unsatisfactory. A metal is required that can be easily machined, and we would like to know whether the copper wire that we are using contains any lead, and the approximate purity of sheet copper.

Answer:—The metal referred to is a good one for bearings and is largely used. It will not fill all requirements, however. No one alloy will do that, and it may be possible that the bearing alloy—copper 80 pounds, tin 10 pounds and lead 10 pounds—will be more suitable for your use. You do not state why the mixture is unsatisfactory, which makes it difficult to advise you. We infer, however, from your use of copper wire that the trouble may be mushiness, that is, a pasty mass forms on the top of the metal and the castings are dirty and occasionally spongy. The remedy is to use charcoal when melting the copper and to push this mass into the crucible when it becomes sufficiently soft so that this can be done. A small handful of salt should also be thrown into the pot when the metal is charged, and when the copper is melted add tin first, then the lead and cover the mixture with charcoal. Next add a half pound of borax and superheat. The metal should be perfectly clear beneath the charcoal covering with no mush to skim off. If you cannot obtain this result your wire must be badly oxidized and in the long run it will pay you to discard the wire and use ingot copper. If this is not possible, and it is a case of using up your own scrap, you should try the deoxidizers.

Manganese is the best deoxidizer to use in leaded alloys because it does not throw down the lead. It must be used with caution, however, or it will cause cold shuts, or probably oxide folds on the backs of the bearings. The use of 1 per cent of 30 per cent manganese copper is recommended at first. You may use more or even less, but you can judge this best by experience. Phosphorus can also be used in this alloy, but where the content of lead is very high, phosphorus will cause the lead to drop. Use 1 per cent of phosphor tin in place of a like quantity of ordinary tin. It is not probable that the copper wire you are using contains lead because the latter would make the copper short so that it could not be drawn into wire. Sheet copper is also good material to use as scrap. If there was any lead present in the wire or sheet copper, it would not harm your mixtures, as alloys are made daily containing from 30 to 50 per cent of lead. —K. K.



HEAT TREATMENT TO WHICH MALLEABLE CASTINGS WERE SUBJECTED, AND THE NUMBER OF HOURS THEY WERE PERMITTED TO REMAIN IN THE ANNEALING OVEN

The Bristol Company, Waterbury, Conn., manufacturers of Bristol's recording instruments, as well as electric pyrometers, has established a branch office in the Frick building Annex, Pittsburg.

A FORGING MACHINE FRAME PATTERN

How it was made to effect the greatest economies in the foundry---Problems of the patternmaker

BY JABEZ NALL

THERE are times when it might be advisable for both the patternmaker and the molder to have a heart-to-heart talk, rather than giving vent to harsh criticism of the other fellow. The patternmaker is only too frequently inclined to under-rate the intelligence of the molder, while the latter, if employed in a jobbing foundry, where he is called upon to handle patterns that come from many sources, frequently has little respect for the ability of the patternmaker and his knowledge of practical molding methods.

While discussing this subject with a superintendent of a general jobbing foundry recently, the pattern, sectional views of which are illustrated in Fig. 8, was shown the writer as a sample of some of the curious models frequently received, from which castings are to be made.

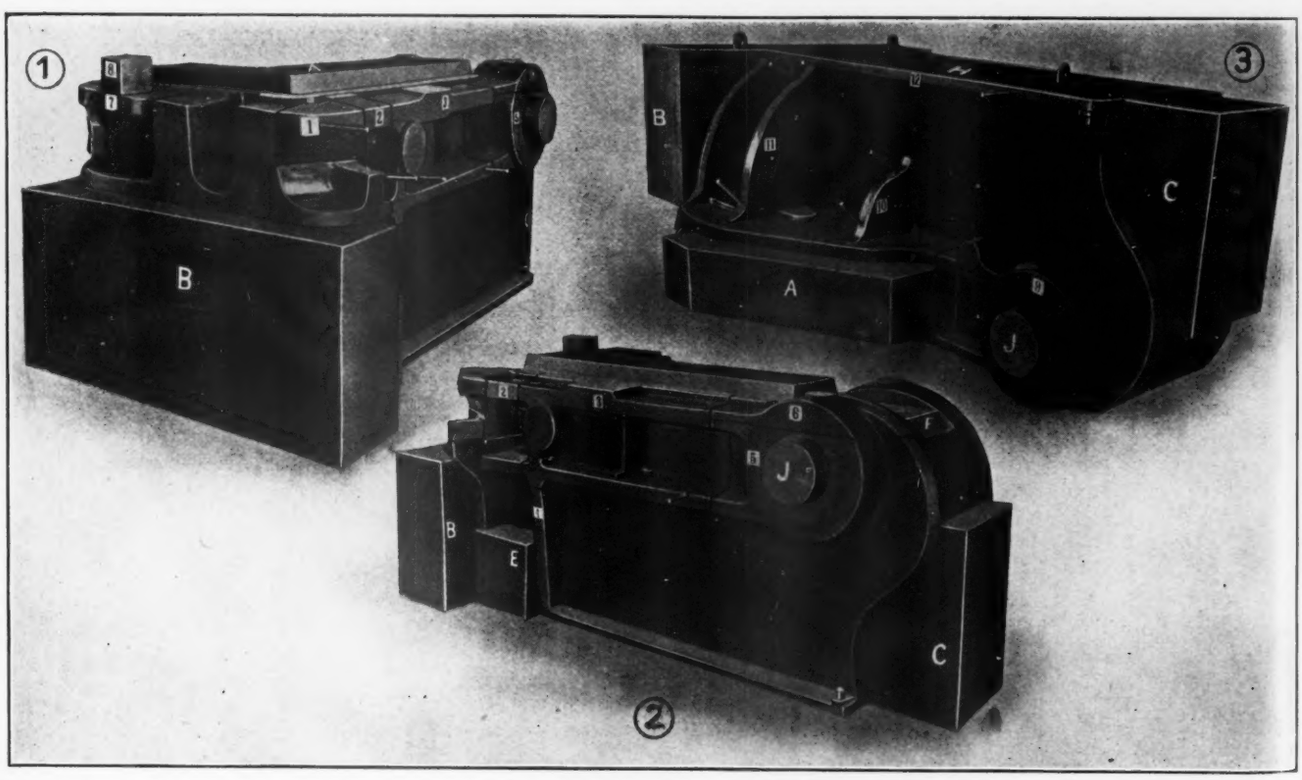
At a is shown in section, a cylindrical pattern, 17 inches in diameter and 20 inches long, provided with four grooves, 2 inches deep, in dovetail form around the outside. These were turned in the pattern in the shape required, the pattern being split in halves. The instructions accompanying the order recommended giving this pattern a half turn in the mold when drawing it out of the sand, which would not only be impractical but impossible without tearing off the narrow rings of sand. Even if it were possible to draw the pattern in this way, the amount of time that would be required to secure these narrow rings would be prohibitive.

Changes Necessary.

A number of these castings were to be made and the superintendent ordered the carpenter to saw out a half circular core box from a flat board as shown at b. The cores made from this box were set in the grooves and rammed in position as shown at c. With these modifications, it was possible for the molder to produce satisfactory molds, and the castings made therefrom were all accepted. How the pattern would have been constructed by a "foundryman's patternmaker" is shown at d and e. This pattern could be molded accurately and with dispatch, resulting in clean castings of the desired size, width and thickness.

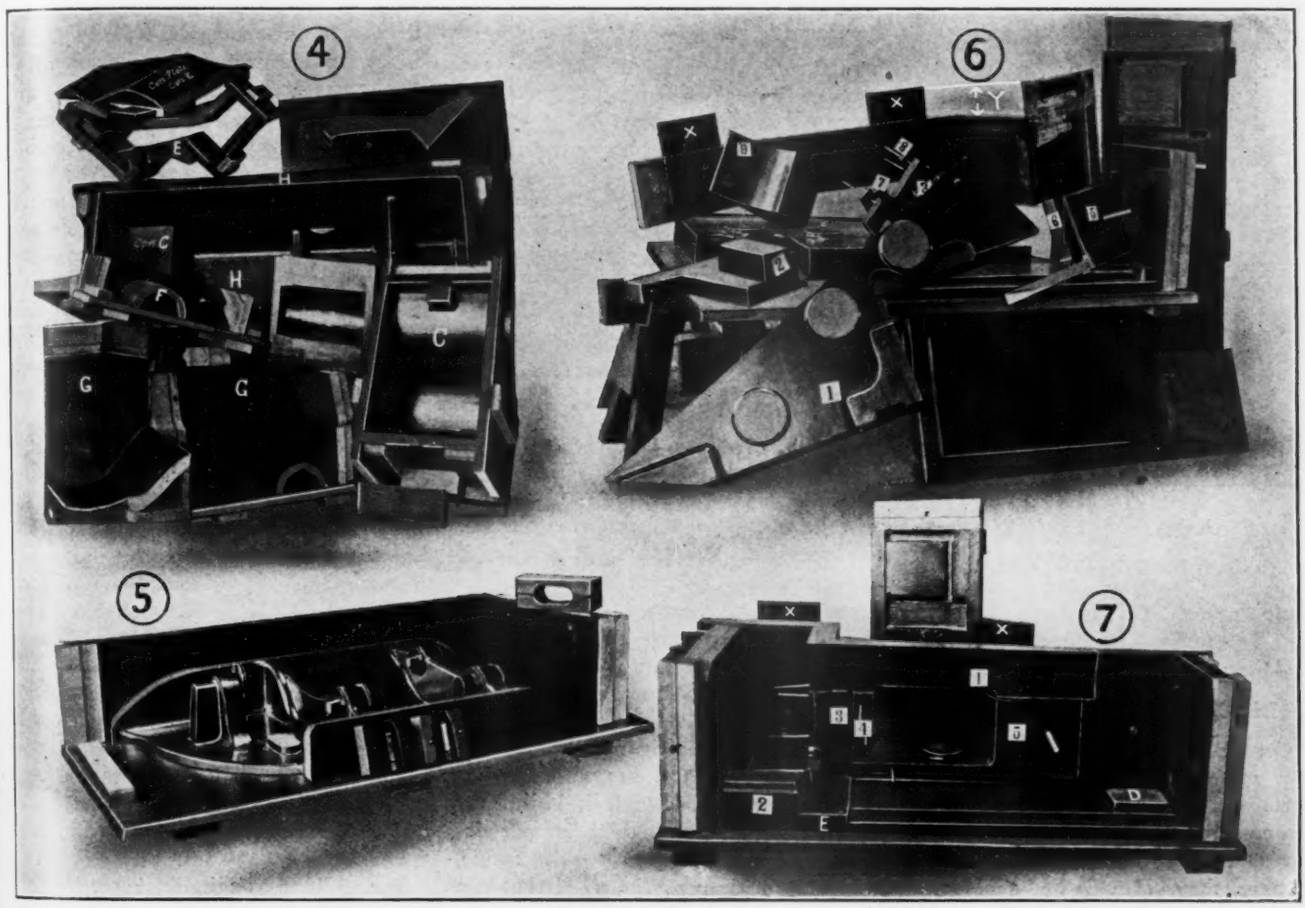
The patternmaker's apprentice, in endeavoring to acquire a knowledge of the art of molding, is frequently confronted with many difficulties, especially by reason of the separation of the foundry and the pattern shop, if they are parts of one establishment, and the rules restricting or precluding visits to other departments than the one in which he is employed. Furthermore, if he is securing his training in a specialty or job shop, widely separated from a foundry, his opportunity for securing a knowledge of molding practice is limited, and will have to be obtained by observation only.

This article has been written for



FIGS. 1, 2 AND 3—FRONT, REAR AND INVERTED VIEWS OF THE FORGING MACHINE FRAME PATTERN

the purpose of explaining some of the ordinary methods of molding in common practice, such as "bedding-in" the pattern, the advantages and necessity of loose parts, stopping-off, the use of drawbacks, etc. In addition, it is hoped that it will stimulate a desire on the part of the apprentice patternmaker to acquire at least some knowledge of the molder's trade, to which his is so closely allied. Furthermore he should rely to a large extent on trade and technical papers, which will give him many suggestions as to the practice in other shops.



FIGS. 4, 5, 6 AND 7—CORE BOXES AND LOOSE PIECES OF THE FORGING MACHINE FRAME PATTERN

Forging Machine Frame Patterns.

To illustrate the construction of an intricate pattern to effect economies in molding, the frames of a small forging machine have been chosen. Figs. 1, 2 and 3 show the front, rear and inverted views of the completed frame pattern. As the molding of the section will principally be dealt with, it is not necessary to give a detailed description of the construction of the pattern. However, as it is necessary to give the reasons for the general arrangement, division of cores, core prints, etc., all loose parts are indicated by figures, and cores, core prints, together with their respective boxes, by letters.

When making any pattern, large or small, the simplification of molding methods to obtain the best results in the foundry, should receive first consideration. Safety and economy are very important, and the first should not be sacrificed to gain the second, as economy is never practiced by taking chances, As the patternmaker must decide upon the construction of the patterns—if he is to adopt the best and most suitable means of molding—he must not only be conversant with the principles of the art, but he should have a knowledge of the different ways that the casting can be made. He should especially be familiar with the practice and equipment of the foundry where the casting is to be made, as what would be the best means to adopt in a well equipped shop, becomes an impossibility in others.

Points to be decided.

In making these frames, a number of important points must be decided before the pattern can be planned. If the casting is to be made of steel, it will require a dry sand mold made in a flask, and under these conditions it would be advisable to avoid the drawback, which is necessary, as indicated in the inverted view of the pattern, to permit of the insertion of core A, Fig. 3. In place of the drawback, a dry sand core should be substituted, and to provide a core print for the same, the lines of the print for core A should be carried to the top of the flange 12, and as far back as core print B. This would also be the best practice when making the frame of cast iron, using a dry sand mold, provided the foundry is equipped with drying ovens and ample crane capacity. However, these castings can be made as satisfactorily, if not quite as economically, by the process of bedding-in in the floor and using a skin dried mold.

Skin Dried Mold.

This method will be described, and the anchor or drawback is to be preferred to the dry sand core for this part of the mold, to effect economies in patternmaking, and to insure equal or better results in the foundry. In the arrangement of the mold, core C does away with a second drawback that would otherwise be required. The use of a drawback in one part of

the mold and a core print and dry sand core in another may be questioned, but in this case the core is small and can be made easily and at a small expense. The core print, to some extent, simplifies the construction of the pattern, the one added expense being the core box. This is more than offset by the saving of time effected in molding.

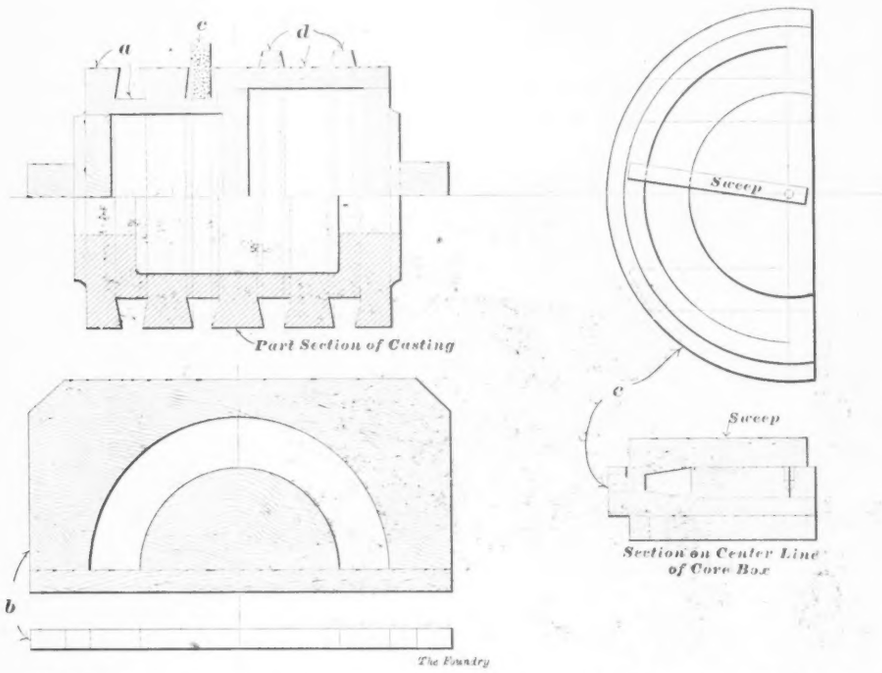


FIG. 8—CYLINDRICAL PATTERN RECEIVED BY A JOBBING FOUNDRY AND THE CHANGES NECESSARY TO EFFECT ECONOMIES IN MOLDING

Disadvantages of Loose Parts.

Core B is used to prevent the further increase of the number of loose parts on the pattern. Loose parts are convenient and necessary at times, but as they do not always insure accuracy, they should be avoided in all cases, unless some distinct advantage can be gained by their use. A further reason for using a core at this point, is that it would be difficult to dry these small cavities sufficient to prevent scabbing or the peeling off of the sand in a skin dried mold, whereas with a dry sand core, this difficulty is overcome. In addition, no fins will be formed on the casting by this core, as its position in the mold does not interfere with the setting of other cores, and it can be set in place while the molder is finishing the remainder of the mold. It thus becomes an integral part of the mold, all joints being finished off before the mold proper is being dried. Furthermore, it can be quickly made by the coremaker and requires less securing than if it were made a part of the mold proper.

In constructing any pattern that is to be bedded in the floor, it is essential that the patternmaker keep in mind the difficulties confronting the molder when ramming the under side of the pattern after it is set in place. With this in mind, he should construct this part of the pattern as simple and as much on one level as possible, so that considerable of the ramming can be done before the pattern is set in place. Any projections that cannot be easily reached, should, if possible, be left loose, so that they may be first rammed or tucked-in merely sufficient to secure their proper location. When molding this frame, the only portion of the mold that can be finished before setting the pattern in place is a level spot sufficient to form a surface for the bottom of core A, but it will be noted that all other lines permit of easy ramming to this point from the outside.

Weighting the Pattern.

After the pattern is bedded in position, which is as a rule accomplished by the free use of a heavy sledge and a block, it should be weighted down before further ramming is done especially if the under side is of large area. Unless the pattern is of sufficient weight itself, this precaution should be taken, inasmuch as it is possible for a molder to unconsciously raise the pattern by ramming from the level bed of sand upon which it rests. This suggestion is made as a result of experience, and cannot be too strongly emphasized, as it is one of the unfavorable features of bedding-in patterns. However, it can be guarded against if the molder is careful. When bedding-in a pattern of this kind, an opening should be made in the floor sufficiently large for the mold, with space enough all around for the molder while at work. This space is also required for the laying of rods to strengthen the walls of the molds, which are placed at all weak corners and for the support of all overhanging sand, as, for instance, between the ribs of loose parts 3 and 5, Fig. 2. This opening should have a depth below the pattern of about 12 inches to provide for a coke or cinder bed about 5 inches thick, and above this sufficient sand should be rammed to resist the pressure of the metal when mold is being cast. The top of the pattern should come to a point slightly below the surface of the foundry floor.

Fig. 9 is a longitudinal section of the mold on the center line of the

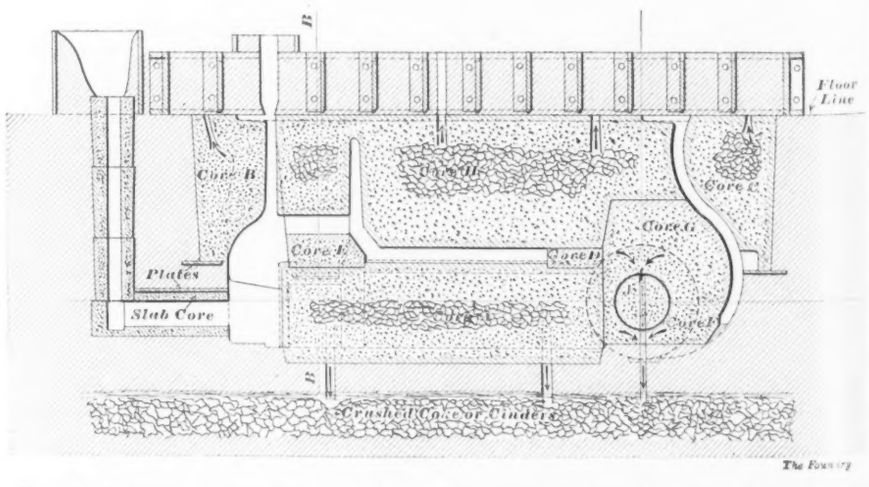


FIG. 9—LONGITUDINAL SECTION OF THE FORGING MACHINE FRAME MOLD ON THE LINE A A, FIG. 10

frame a a, Fig. 10, which also shows a cross section of the mold on the line B B, Fig. 9. These views together with those of the pattern in Figs. 1, 2 and 3, illustrate the arrangement of the mold, the division of cores, etc. The arrows in cores B, H and C, indicate the direction of the vents for carrying off the gases, while the lower cores are vented through the cinder bed below the mold, from which point they are carried up through pipes to a point above the floor line, as shown in Fig. 10. The upper cores are vented through the cope.

Core Boxes.

Fig. 4 shows a group of the smaller core boxes, and Fig. 5 gives a view of the box for core B with one side and one end removed to show the interior, as well as the box for the babbitt metal bearings. These boxes differ somewhat in the arrangement of core prints, a cone print being provided on the one side coinciding with the box, and on the other side a tail print is on the lugs but not on the bearing box. The core prints attached to the facings are dovetailed in place as shown. It will also be noted that the box is left sufficiently short to permit of its insertion in the cone and it is then pushed forward into place, leaving a space behind to be filled in or stopped-off along with the tail print, a special stop-off piece being provided which is not shown. This is cut out to straddle the core, having on its face a fac-simile of one-half of the facing in order to keep the impression. To accomplish this, it is necessary that the tail print be made to suit the large diameter of the core as shown.

Figs. 6 and 7 show two views of the box for core A. The various parts are illustrated in Fig. 6, and the box partly assembled is shown in Fig. 7, the front side of the box being removed and is shown projecting above the core box at the back. This core was formerly made in three separate parts, but as this arrangement always resulted in more or less trouble in the machine shop, it was constructed as shown. This core contains the principal parts of the castings that are to be machined, and after it was made in one section there was no further trouble.

The coremaker at first did not comprehend the economies that could be effected by the change, but later found that he could make the combined core as cheaply as the three individual cores. On account of the size of this core when making frames for larger machines of this type, the method of making this core in three sections is still adhered to. Pieces X are attached to the side of the box for the purpose of supporting the drying plate on a level when rolling over, space Y, Fig. 6, being filled in with molding sand.

Anchor.

A plan view of the anchor casting which supports the drawback is shown in Fig. 11, and a sectional view of the same is illustrated in Fig. 10. This, together with a few gaggers properly placed, insures an effective and safe lift for this body of sand. Loose part 8, Fig. 1, located above part 7 at the front of the pattern, is a core print for a lug cast on part 7. This lug is higher than the thickness of the rib, and with the core print added is about twice as thick, thereby making it impossible to draw this into the space left by the withdrawal of the rib after the ramming of the pattern has been finished. How to overcome this difficulty is one of the kinks of molding that can be advantageously applied in many cases. In this case, however,

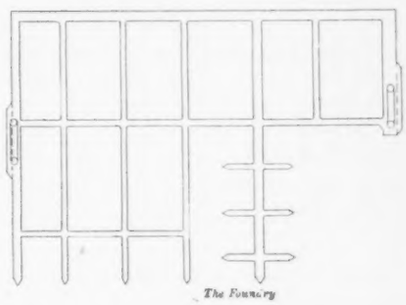


FIG. 11—ANCHOR USED TO SUPPORT THE DRAWBACK

the lug could be cut in two parts and could be taken up through the space left by the removal of the rib, but there still remains the question of drying, so that it is advisable to use a dry sand core for this part. The core print for this lug is rammed with part 7 in place. This is also rammed up as far as the center, the rib is then temporarily removed, print 8 is withdrawn and the core is set in place, rib 7 again being returned to its position. This covering core prevents sand from falling into the impression as the ramming of the mold is proceeded with This use of covering cores will be discussed in another article.

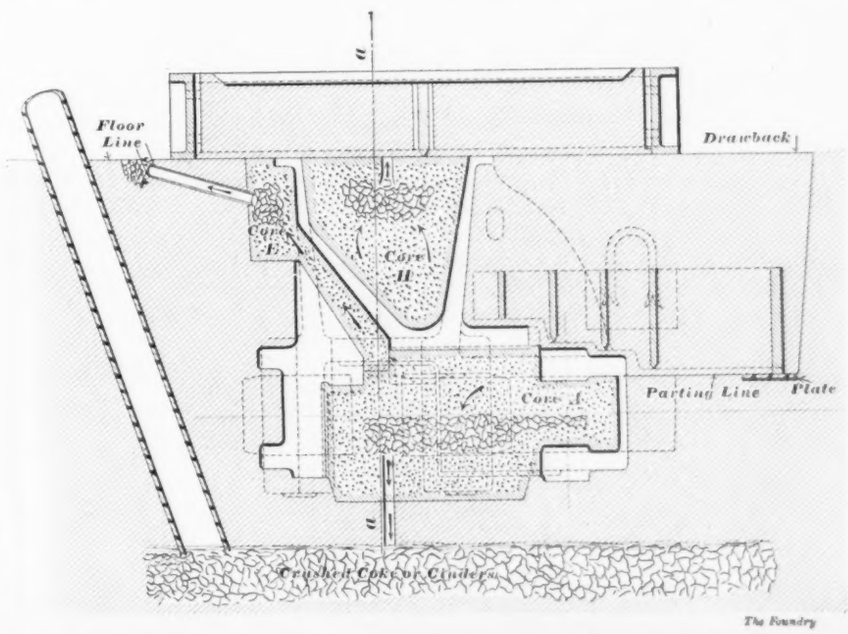


FIG. 10—CROSS SECTION OF THE MOLD ON THE LINE B B, FIG. 9

PHILADELPHIA FOUNDRY FOREMEN.

At the September meeting of the Associated Foundry Foremen of Philadelphia and vicinity, held in Odd Fellows Temple, Philadelphia, Nils Anderson, of the Debevoise-Anderson Co., New York City, read a very interesting paper on Solvay coke. The comparative value of by-product coke and that manufactured in the bee-hive type of oven for foundry use was discussed, and it developed that this coke is being successfully used in a number of Philadelphia foundries. The effect of charging limestone in the cupola containing lime varying from 52 to 95 per cent was also considered at length.

The July issue of *The Blast*, published by the Detroit Foundry Supply Co., Detroit, in addition to descriptions and illustrations of foundry supplies and equipment, contains much interesting reading matter relating to foundry work.

A NEW PROPELLER MOLDING METHOD

A simple and improved method of making these wheels whereby foundry costs can be greatly reduced

BY J. F. BUCHANAN

MOLDING a propeller wheel is a somewhat hackneyed piece of work, and unless one has some novelty to introduce, either in the design or in the molding practice, it would be a waste of time to dwell upon a subject which is so familiar to the foundry fraternity already. By the several methods by which these well-known castings are made, the choice mostly depends upon the size of the wheel. Those of very large diameter, say from eight feet and upwards, are invariably gotten out by the use of loam boards; those of medium size, say from four feet and up to about eight feet, are generally molded in sand from a part pattern consisting of the hub and one of the blades. The smaller wheels may be made entirely in cores as described in THE FOUNDRY, March 1908, or in green sand from a complete pattern in the ordinary way.

FIG. 1—CROSS SECTION OF PROPELLER MOLD

Due to the fact that a built pattern is necessary to give the screw part of the pattern sufficient strength and stiffness for molding in the damp sand, the making of a full pattern involves considerable expense. This accounts for the popularity of the single blade type which can be built for about one-third of the cost of a complete pattern. When a mold for a wheel with three or four blades is to be developed from a single blade and hub pattern, the hub portion is usually made to fit over a center spindle which works in a tapered socket fixed in the floor bed, or on a foundation plate.

Change in Bottom Core Print.

The preparatory work of fixing the socket, plumbing the spindle, sweeping the bed and marking off, according to the number of blades, Figs. 1 and 2, takes up a lot of the molder's time. By a very simple alteration to the form of the bottom core print, all of this preliminary work can be avoided and a straight-forward bedding-in job made of the wheel. For a four bladed propeller, similar to the one outlined in Fig. 2, a square print of sufficient depth and taper is all that is required. Fig. 5 is a plan view of this print. An end view and plan of the core box are also shown in Figs. 6 and 7.

To mold a wheel, a bed is prepared on which the pattern is knocked down to a level position, taking care to ram around the sides of the print firmly. After the ramming of the first blade is completed and the joint formed, the pattern is withdrawn, leaving one-fourth of the drag mold ready. The three remaining sections are made up in the same way, the exact position of each successive blade being found by fitting the print carefully into the mold with the corner one removed from its previous position.

The print is of the utmost importance in getting out castings of any sort, but in this case where it is the only guide to a true radial setting, and the divisor of the sum, special attention should be given to it. The sides should be exactly alike in width and taper, so that when the pattern is turned from one position to another it may be reset without injury to the mold. Fig. 3 illustrates the pattern for a screw propeller having two blades only. The dotted lines indicate the position of the second blade when the pattern is turned in the mold. By changing the bottom print, three blades or four

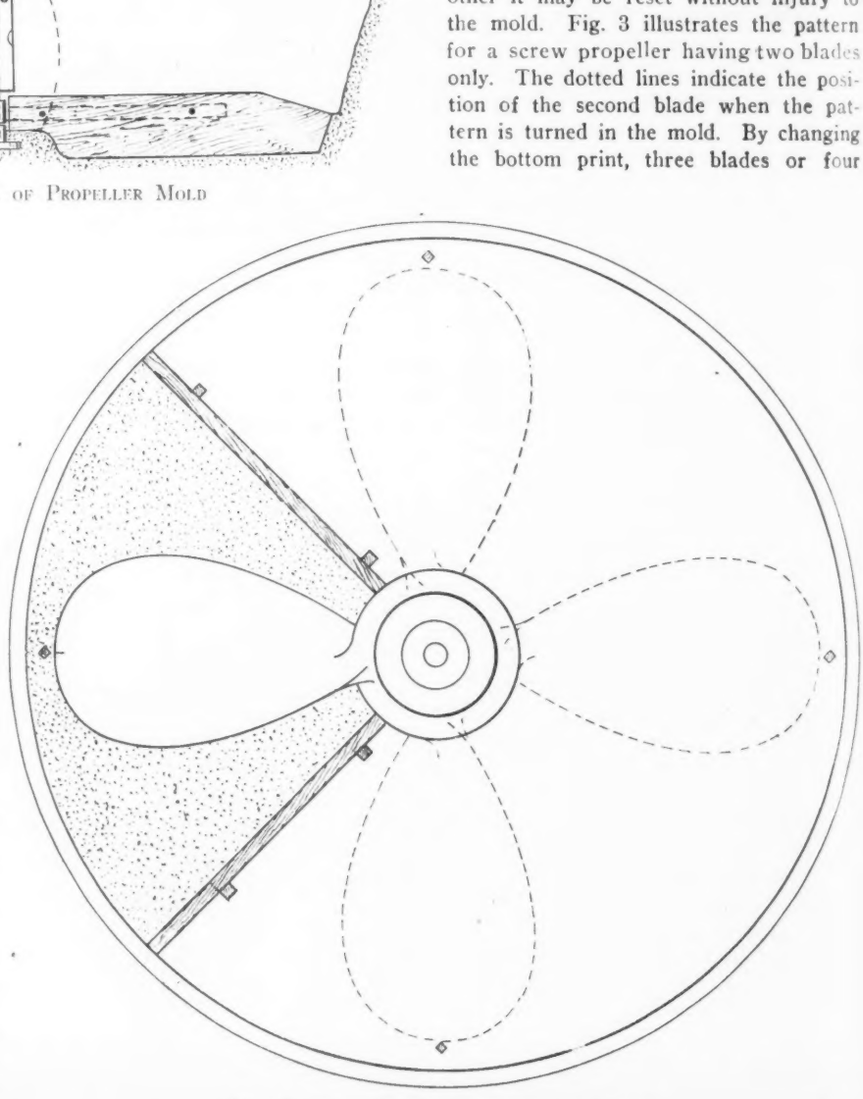


FIG. 2—PLAN VIEW OF PROPELLER MOLD

blades, Figs. 4 and 5, may be developed as required; in every case the print serves to locate the number and position of the blades.

Idea Applied to Segmental Pattern.

An advertisement writer would probably say of this device, "Its all in the print." And so it is, but this idea can be applied further to all kinds of segmental patterns even when there is no core in the center of the casting. A peg or pivot with a figure conforming to the required section and the number of divisions may be used, and when the mold is complete the gap created by this peg-like pivot may be filled up with sand. Needless to say, this kind of pattern is only advantageous where occasional castings are called for. For continuous work something better, even if it should be more expensive, would certainly commend itself.

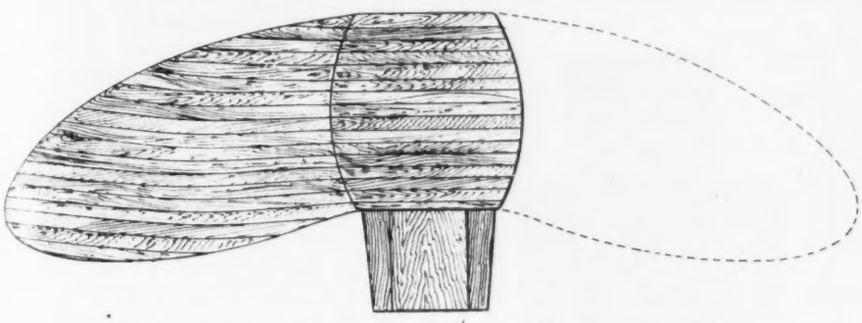


FIG. 3—PATTERN FOR SCREW PROPELLER HAVING TWO BLADES

Motor Boat Propellers—Some Novelties in Blade Design.

That most fascinating pastime, motor boating, has created a demand for some newer types of propeller wheels. Such wheels have to be designed for engines running at very high speeds, 700 revolutions and upwards being quite common. This necessitates the use of a strong, tough metal with high elastic limit. Manganese bronze is the metal mostly used for these castings. The superior strength of this metal permits of lighter sections in the blades, and its non-corrosive quality is a further recommendation for its use. To any one accustomed to melt "high brass" alloys, the mixing of manganese bronze in a crucible should present no difficulty. An easy method of producing the bronze is to melt a given quantity of brass, copper and zinc only, and add six percent of copper manganese and ½ per cent of aluminum 15 minutes before pouring. The metal must be very fluid to run small wheels in green sand. In every case a knife-edge blade is essential. Where stock patterns are used, they are generally made in metal from plaster casts. Owing to the thin section and delicate form of the average blade design, wooden patterns would not be profitable. The superiority of particular models does not concern the foundryman, but sometimes the design will add to the ordinary labor and casting risks.

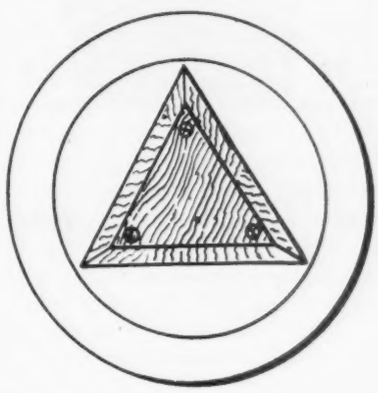


FIG. 4—BOTTOM PRINT FOR PROPELLER WITH THREE BLADES

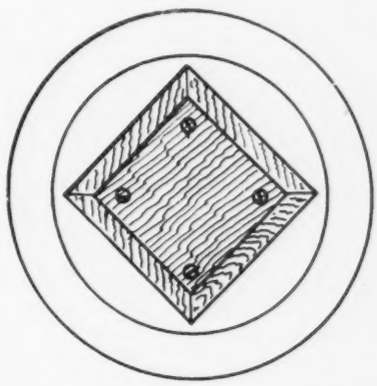


FIG. 5—BOTTOM PRINT FOR PROPELLER WITH FOUR BLADES

Design of Propeller.

The designing of screw propellers has exercised the minds of marine engineers and inventors for over half a century, but without any very conclusive results. From a note book I herewith reproduce the outlines of some of the novelties in propeller blades that have come my way, Fig. 8, A to G. It is well known that the greatest loss of power in propellers is due to skin friction of the blades moving through the water. At A we have a propeller designed to reduce the blade area where the friction is greatest; B is a hooked blade designed to assist a ferry boat in maneuvoring at wharves, the hook being on the back of the propeller checks the speed quickly when the engines are reversed; C is a double-faced propeller giving the same power going astern as ahead; D is a design suitable for a high speed. E, F and G are examples of the "throw-back" and other devices meant to increase the surface on wheels without increasing their diameters; G is for vessels of shallow draught.

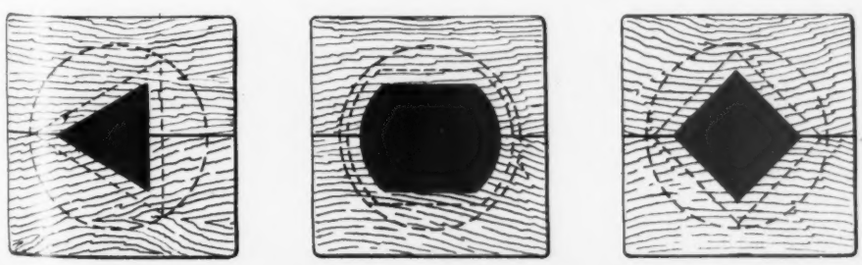


FIG. 6—END VIEWS OF CORE BOXES

THE TAPERING SNAP FLASK.

By THOMAS F. KENNEDY

Some of the most ingenious contrivances ever devised by molders and patternmakers were designed to overcome difficulties presented by some special job which was never made before and may never be made again. I recall many jobs of this kind, and to tell how one was handled might be interesting, but the possible application of the plans developed being so restricted, any one of them would be of practical value to but a very limited number of foundrymen. Next to cupola practice my subject will interest as many foundrymen as any that could be selected.

Not Impertinent.

To those using the tapering snap flask, who know its value, writing to point out its merits and recommend it to foundrymen might seem an impertinence; and if all knew its value an impertinence it would be. But all do not know; some large users of snap flasks do not even suspect the existence of tapering snap flasks. That even the very brightest foundrymen may not know or, knowing, not ap-

preciate their value was very forcibly brought home to me upon a recent visit to a large, and in every other respect, well-equipped, well-managed foundry.

Everywhere were evidences of ingenuity, almost inspiration, indicating a genius somewhere, the superintendent himself I suspected. And yet although 30 tons a day of the large output was molded in snap flasks, they were straight ones with from two to five grooves in the side; and in this era of progress, of wireless telegraphy and flying machines, wooden corner blocks. So the number of things they did not know about snap flasks in this foundry, the property of one of the richest corporations in the country, determined my choice of a subject.

Corner Blocks.

On jobs that can be poured without jackets, straight grooved flasks are satisfactory, but jackets or no jackets, corner blocks are a rank offense against good practice. If jackets are used, every one made must have corner blocks fitted to and nailed in, and whether many or few, this is a wanton waste of labor which could be avoided by keeping the corners square.

Grooves an Unnecessary Evil.

Straight or tapering, where jackets must be used, grooves should not be tolerated. The jackets must shave the grooves off. Unless all sand is passed through a riddle every time it is used, bits of scrap, old soldiers, nails and pieces of cores find lodgment in the grooves. Every time this happens it means the destruction of a mold, causing, nearly always, a fire, burning jackets and bottom boards, and causing general confusion and perhaps the loss of other molds.

Banish grooves, and in their stead allow the metal binding on the bottom side of the cope or cheek to extend in just a trifle. How much this should extend in will depend upon the size and depth of the cope or cheek, and the nature of the sand used. It can easily be shifted and a very little experimenting will determine the rule for the shop.

For Heavy Work.

Where the work is of such a nature that jackets must be used, the tapering flask without corner blocks or grooves is such a vast improvement over the other that even the most skeptical and conservative has but to give it a trial to induce him to adopt it. The adoption of many a good contrivance is delayed for the want of a fair trial.

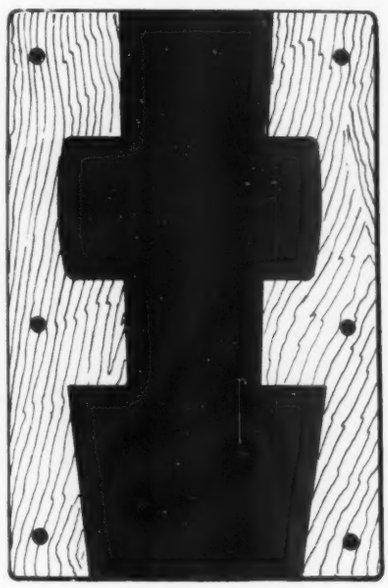


FIG. 7—PLAN VIEW OF CORE BOX

If you buy one tapering snap flask, no matter how well made, the carpenter will find it a tedious job fitting jackets to the mold; and unless he is a good workman they won't fit at all, and the tapering flask will be condemned. I know that the difficulty of fitting jackets to them has heretofore been an objection. But that has been overcome by first making a form upon which to build the flask, and using this form. Any old wood butcher can make jackets that are bound to fit the mold.

An admirable substitute for grooves is a sand strip formed by allowing the binding on the lower side of the cope to project in a little. Try ⅛-inch and if that is not sufficient increase it until the mold holds.

Besides the destruction of straight molds caused by the jackets catching on nails, scrap or cores, there is loss from the jacket failing to hold the mold, and still greater loss from the mold being crushed by the jacket even when it fits well, caused by the haste and hurry of casting, by the molder not keeping its side parallel with the sides of the mold.

With jackets that fit exactly, except through gross carelessness in failing to push the jacket down hard, it is impossible to lose a casting on account of the jackets, if the mold has been made in a tapering flask.

One can allow nails, scrap, cores and old soldiers to accumulate in the sand heap until it won't hold together any longer, and yet a tapering jacket going on a tapering mold will never cause the loss of a single casting.

If everything is exactly right, and the jacket is pushed on tight, it has a holding down power on the outer edges of the mold equal to the weight of the whole mold; this, of course, in addition to its main function—the taking of the side strain.

I have seen tapering snap molds with a 40-pound weight on them stand the strain of a 40-pound casting with no more indications of weakening than would be shown by a barred iron flask.

No hard and fast rules need be observed in tapering, but for most sizes ¼-inch difference between top and bottom will give satisfaction.

Like so many good things no one seems to know who was the inventor

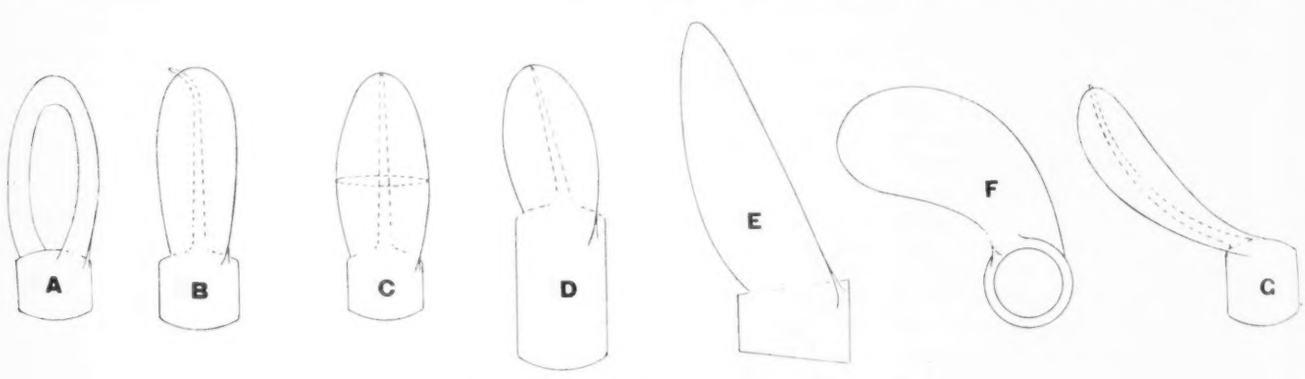


FIG. 8—A FEW NOVELTIES IN PROPELLER BLADES

of the tapering snap flask. Neither do I know who first used the form, the device that makes it so easy to fit the jackets to a tapering mold; but the first man I ever knew to make use of it was George Booker, foreman of a large malleable casting plant in western Pennsylvania.

FOUNDRY DAY AT THE ALASKA-YUKON-PACIFIC EXPOSITION

ON Monday, Sept. 6, the interests of the foundrymen of the Pacific northwest were centered at the Alaska-Yukon-Pacific exposition at Seattle. An elaborate program, including demonstrations of modern foundry methods and equipment, was presented at the exposition foundry by the United Metal Trades Association of the Pacific coast and under the direction of Commissioner H. S. Hastings was executed with unusual precision and success. The foundry day program was an event of more than passing importance because it marked one more decided step toward the general adoption of strictly modern methods by the Pacific coast shops.

The purpose of the demonstration was purely educational and it was held on Labor Day so as to give the employes of the various organizations the largest possible opportunity to be present. As was stated in a circular issued by the Metal Trades Association: "There has never before been such an opportunity on the Pacific coast to procure the educational and practical features that are to be offered to you here on this holiday when your shops are closed and your employes can be present." It was the first educational demonstration of modern foundry practice that has ever been given at any point west of the Mississippi river. The success of the demonstration has assured its becoming an annual feature which will grow in importance and influence from year to year. Inasmuch as the exposition foundry is a permant building, reverting to the mechanical engineering department of the University of Washington, there will be no difficulty in finding a suitable place for holding successive demonstrations.

Attendance Large.

The attendance was very heavy, nearly every foundry in Washington and northern Oregon sending one or more representatives. In addition to this there was a constant stream of casual visitors coming and going throughout the entire day. It is estimated that the total number of people who saw all or a part of the demonstration exceeded 5,000.

At 9:30 a. m. the 22-inch cupola in the exposition foundry was charged with coke to a point 28 inches above the tuyere line; on this bed was placed a 500-pound charge consisting of 50 per cent steel scrap, 35 per cent Han Yang, Chinese pig iron and 10 per cent silvery pig. Boiler and forge shop scrap, punchings, croppings, rivets, bolts, etc., comprised the steel portion of the charge.

This mixture was followed by one consisting of 25 per cent steel scrap, 65 per cent Chinese pig and 10 per cent silvery pig, which in turn gave way to a mixture of 50 per cent car wheel centers, 40 per cent southern pig and 10 per cent silvery, this being followed by another similar mixture using car wheel rims instead of centers. The object of the last two mixtures was to show that the white, chilled rims or the gray, unchilled centers of car wheels, when used with the same proportions of pig iron, will produce identical castings, the chill having no effect after remelting.

Standard test bars, 26 inches in length and having 2 by 1-inch cross sections, were cast from each mixture and broken on an Olsen transverse testing machine, the bars being broken on 24-inch centers. Bars from the 50 per cent steel mixture broke at 3,000 pounds per square inch, with deflection of 0.3 inch and a white fracture. The 25 per cent steel mixture showed 3,500 pounds breaking strength, a deflection of 0.491 inches and a gray fracture. The bars made from the two car wheel mixtures showed identical characteristics; each of the tests indicated a transverse strength of 2,800 pounds per square inch, a deflection of 0.430 inches and a gray fracture.

At the same time, a specimen of high tensile strength manganese bronze was melted in the Steele-Harvey brass furnace and cast into ingots.

Demonstrations of the latest molding machine practice were given on three types of molding machines built by Henry E. Pridmore, Chicago, and The Adams Co., Dubuque, Ia.

The waste iron in the cupola drop was recovered in a cinder mill exhibited by the W. W. Sly Mfg. Co., Cleveland, weighed and saved for remelting. The spectators were deeply interested in the amount of iron reclaimed from the drop by the cinder mill.

The Afternoon Session.

Following an intermission for lunch at the New York building, was a demonstration of the forging and dressing of high speed steel by A. J. Ross, foreman of the smith department, Washington Iron Works, Seattle. These tools were afterwards tested in the machine shop, one tool was driven at a speed of 50 feet per minute through tool steel, the depth of cut being 3/16 inch and the feed 3/64 inch, for one hour without appreciable damage. The necessity for special tools designed to utilize the full benefits derived from high speed steel was vividly illustrated by the failure of the lathes at hand to drive the high speed steel tools at their most efficient speed and depth of cut.

The program was concluded with a demonstration of autogenous welding by the Seattle Oxy-Acetylene Co., and a demonstration of the thermit process of welding by the Thermit Co.

Credit for the success of the Foundry Day program is due to Herman S Hastings, commissioner of the United Metal Trades Association of the Pacific coast. In his work in connection with Foundry Day, Mr. Hastings had the co-operation of Prof. E. O. Eastwood of the University of Washington and a number of others prominent in educational and industrial circles in the northwest.

The cupola demonstration was in charge of J. H. Linton, consulting foundry specialist, Seattle, assisted by L. G. Blunt. The brass furnace was operated by A. W. Gregg of the Pacific Coast Testing Laboratory, Seattle. The molding machine demonstrations were under the supervision of R. E. Turnball, special representative of Henry E. Pridmore, Chicago.

COKE PRODUCTION IN 1908.

According to a report compiled by the United States Geological Survey, the coke production of the country in 1908 amounted to 26,033,518 tons, as against 40,779,564 tons in 1907. The production in 1908 was 36.14 per cent less in quantity and 43.98 per cent less in value than during the preceding year.

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Trade Outlook

All grades of pig iron were advanced from $1.50 to $2.00 a ton during September, and the heavy purchases by large interests foreshadow still higher values. While the actual requirements for consumption are undoubtedly very large, nevertheless, it may be seriously doubted whether some prices now quoted are not too high. Pig iron production is steadily increasing, and many furnaces are holding back large tonnages consisting of stocks accumulated during the last 18 months. As prices advance, additional furnace capacity will become operative, and it is probable that the high quotations will prove an incentive to blow in many old stacks that have been idle for several years. In the south, $15.00 is being asked for No. 2 foundry, for shipment during the first half of the year, and Mahoning and Shenango valley operators are quoting $17.40, Pittsburg, for early delivery. In the west, local No. 2 is held at $19.00, Chicago, with Lake Superior charcoal unchanged at $20.00. In the east, No. 2 X foundry is quoted at $18.50, New York and Philadelphia. Although the stocks of scrap in the hands of dealers are larger than at any time in the past two years, prices are steadily advancing, while foundry coke has been marked up at least 50 cents a ton. This rapid increase in the cost of raw materials is compelling foundrymen in all branches of the trade to ask higher prices, and while low quotations are still being named, it is certain that they will soon be withdrawn. While the reversal of trade conditions has not benefited the founders to the same extent as the steel manufacturers, nevertheless, idle casting shops are being placed in operation every day, while the malleable and steel foundries, especially those making a specialty of railroad work, are slowly falling behind in deliveries. The extensive buying of machine tools is reflected in the heavy demand for machinery castings, and the jobbing shops report a constantly increasing melt. Despite the tremendous consumption of non-ferrous metals, prices remain practically unchanged, and scrap is abundant in all centers. The brass founders are unable to cope with the demands of the automobile trade and many new plants are being erected to meet the requirements of this industry.

THE HOODOO IN PIG IRON.

To the Editor:—Replying to N. W. Shed's communication in the September FOUNDRY, regarding the "hoodoo in pig iron" I wish to take exception to his statement that he hopes this superstition will be permitted to die a natural death.

While unable to claim 25 years experience, the writer, nevertheless, is in a position to state that there is a vital difference in different pig irons of the same general composition. In my experience as a foundry chemist, the opportunity has been afforded to become more or less familiar with the operation of a large number of foundries, and I am forced to admit that there is some quality in pig iron which the chemical laboratory is unable to determine.

Mr. Shed asks for a published list of the furnaces which make unsuitable pig iron, but this would obviously be a decided mistake. A black-list is always to be deplored and an iron found unsuitable for one class of work would not be found so for castings widely different in design and section.

The writer was very recently called in to advise a foundry making a specialty of automobile cylinders. The storage yard contained a number of brands of pig iron of suitable chemical composition, and as the daily analysis of the cast was entirely satisfactory the writer was forced to fall back upon the "superstition" that the pig iron was at fault. Another brand was used with a still greater loss, although the laboratory could detect no difference in the chemical composition. The next brand of iron tried was found eminently satisfactory, and we believed the problem was solved. A few days later a car of iron was used and the only remaining car of that brand was a trifle low in silicon, and it was decided to use 10 per cent of a third brand to make up this difference. This third brand was undoubtedly one of the "bad irons" for it caused a loss of upwards of 50 per cent. The next day this 10 per cent was left out, the deficiency in silicon being made up in another way, with the result that the cylinders were satisfactory. The results of the third day prove conclusively that the quality of the pig iron, and not any chemical difference was at fault. The mixture of the third day was identical with that of the day previous, but the usual 20 per cent of foundry returns used were from the heat containing this "off" iron with the result that there was another heavy loss. When it is considered that on the third day there could be present but 2 per cent of this par-

ticular pig iron, it must be admitted that this deleterious quality is an extremely potent one. Needless to say, the chemical contents were maintained practically uniform.

As a foundry chemist, and interested in chemistry, I do not like to assert that chemistry *per se* is not all-sufficient, but the result of my experience compels me to do so, and although chemistry is doing wonderful things for the foundryman, it must be used intelligently and in conjunction with the mechanical processess and methods.

Instead of letting the superstition die, let us investigate it with an unbiased and open mind and get at the bottom of that unknown quantity which most certainly exists in pig iron

ROBERT H. HOOD.

PERSONAL.

Carl M. Beattie has resigned as foundry foreman of the Troy Malleable Iron Co., Troy, N. Y., to accept the position of superintendent of the new malleable shop recently completed by the Vesper Safety Clevis & Malleable Iron Co., Vesper, Wis.

George A. Burman has been appointed superintendent of the plant of the Shirley Radiator & Foundry Co., Shirley, Ind., succeeding his brother, T. N. Burman, who recently resigned and is now residing in Cleveland at 10115 Olivet avenue.

J. F. Gaffney, who was connected with the S. Obermayer Co., Cincinnati, for some time, has resigned to accept the position of general superintendent of the Singer Mfg. Co.'s new foundry at Stanhope, N. J.

B. W. Pharis has accepted the position of superintendent of the iron and brass foundry operated by the Davison & Namack Foundry Co., Ballston Spa, N. Y.

T. P. Kelly, of the foundry supply house of T. P. Kelly & Co., New York City, returned recently from a four months' European trip.

W. M. Corse, secretary and treasurer of the American Brass Founders' Association, has accepted the position of works manager of the Lumen Bearing Co., Buffalo, manufacturer of Lumen bronze, manganese bronze, aluminum castings, etc. After Oct. 1, all communications from members of the American Brass Founders' Association should be addressed to Mr. Corse in care of the Lumen Bearing Co.

George Muntz, who has had a wide experience in foundry work, both in France and in the United States, is now associated with the Tropenas Steel Co., New Castle, Del.

James I. Dissette, after 21 years of service, recently resigned as vice president of the Indianapolis Foundry Co., Indianapolis. His holdings were purchased by Frank W. Lewis and Fred B. Whitlock, president and secretary respectively.

Robert E. Turnbull, representing Henry E. Pridmore, molding machine manufacturer, Chicago, has gone to Seattle to take charge of the Pridmore molding machine exhibit in the model foundry at the Alaska-Yukon-Pacific exposition.

G. H. Griffiths, of the Toowoomba Foundry Co., Brisbane, Queensland, Australia, is now in this country on an inspection tour of iron, steel and brass foundries.

Samuel H. Dougherty, for many years St. Louis sales manager of the Joseph Dixon Crucible Co., Jersey City, N. J., has severed his connection with that concern and is now associated with the Jonathan Bartley Crucible Co., Trenton, N. J., as its western representative.

Thomas Murphy, who formerly operated a brass foundry in Jersey City, N. J., has accepted a position as foundry foreman with F. H. Lovell & Co., Arlington, N. J.

OBITUARY.

David Pyott, one of the pioneer foundrymen of the west, and a member of the firm of Holmes, Pyott & Co., died Sept. 3, at Mackinac Island, aged 80 years. He was born in Dundee, Scotland, and located in Chicago in 1854. The firm in whose establishment he played a prominent part, was organized early in the 60's and enjoys the distinction of being the only one of its kind which survived the Chicago fire.

George L. Fisher, formerly president of the Fisher Foundry & Machine Co., Pittsburg, died in that city Sept. 5, aged 70 years. Born in Germany, he accompanied his parents to this country in 1852 and when a young man he organized the Fisher & Wenzell Foundry Co., which erected a plant at South Twenty-first and Mary streets. The firm name was later changed to Fisher & Thomas, continuing as such until 1885, when Mr. Fisher became sole owner. His sons were associated with him in the foundry business and managed it after his retirement in 1901.

Chas. X. Cordier, eastern sales agent of the Ross Tacony Crucible Co., Philadelphia, died in New York city, Aug. 31.

THE IRON AGE SOLD.

Announcement is made that negotiations have been consummated whereby the ownership of the David Williams Co., publisher of *The Iron Age, The Metal Worker* and *Carpentry and Building,* has passed to other interests, in which Charles T. Root, C. G. Phillips, I. A. Mekeel and Wm. H. Taylor are the predominating figures. The Williams Printing Co. does not figure in the transfer.

The Iron Age was founded 55 years ago at Middletown, N. Y., under the name of *The Hardware Man's Newspaper,* which was changed a few years later to *The Iron Age.* Headquarters of the journal were removed to New York in 1864, and four years later, John Williams, founder of the journal, sold it to his son, David Williams, by whom it has since been published.

It is announced that no changes are contemplated either in the policy of the publication or in its editorial and business staff. Charles Kirchhoff, who has been associated with the paper for 32 years, will remain as an official of the company and in charge of the editorial department. Mr. Root is publisher of *The Dry Goods Economist* and several other trade publications. Both Mr. Phillips and Mr. Mekeel have been associated with him for many years and Mr. Taylor is best known as publisher until recently of *The Engineer.*

AUTUMN MEETING OF THE INSTITUTE OF METALS.

The autumn meeting of the Institute of Metals will be held at Manchester, England, Oct. 14 and 15. The following papers will be presented.

"The Constitution and Properties of the Ternary Alloys, Aluminum Copper-Tin", by J. H. Andrew and C. A. Edwards.
"The Surface Appearance of Solders", by C. O. Bannister and H. J. Tabor.
"The Technical Assay of Zinc", by H. W. Greenwood.
"Notes on the Production of Pure Spelter", by J. S. G. Primrose.
"Some Causes of the Corrosion of Copper and Brass", by E. L. Rhead.
"The Elastic Break-down of Ductile Materials", by Prof. C. A. Smith.
"The Copper-Zinc Alloys, A study of Volume Change During Solidification," by Prof. T. Turner and M. T. Murray.

The A. Buch's Sons Co., Elizabethtown, Pa., manufacturer of gravity molding machines and foundry equipment, has opened a sales office and demonstrating room at 999 North Marshall street, Philadelphia. A gravity molding machine, as well as a portable jarring and squeezer machine made by this concern will be installed and operated in this show room. C. A. West and G. E. Bates will be resident managers of this branch.

FOUNDRY AND PATTERN SHOP EQUIPMENT

Tilting crucible furnace --- Continuous annealing and hardening furnace --- Plain jolt molding machine --- Chain block --- Cinder crusher --- Double spindle polishing lathe

THE tilting crucible furnace for melting iron, brass, bronze and aluminum, shown in the accompanying illustrations, invented by E. H. Schwartz and built by the Kroeschell Bros. Co., Chicago, embodies the principal features of the Kroeschell-Schwartz gyrating flame, stationary crucible furnace. As shown in Fig. 3, the furnace is provided with two covers, the upper one closing an opening in the lower cover through which the metal is charged into the crucible. After the charging operation is finished the upper cover is lowered. To permit the products of combustion to escape, an opening, 3 inches square, has been provided in the upper cover. As shown in Fig. 1, a special crucible is used which is firmly wedged in the furnace and is not removed until it has to be replaced. The gyrating flame principle of heating the crucible results in melting the metal in the bottom of the pot first, an exceedingly important feature in the melting of metals, and which greatly reduces oxidation. The furnace is provided with trunnions which rest on two cast iron supports, the trunnions being placed below the center to insure the easy tilting of the furnace by means of a hand wheel and gearing when the crucible is filled with metal. The door shown at the bottom of the furnace covers an opening from which the slag or spilled metal discharges automatically, and it is impossible to clog the slag opening. When pouring the metal, the furnace is completely closed, as shown in Fig. 3, with the exception of the removal of the cover shown underneath the furnace in this illustration, which closes this opening when the metal is being melted, as shown in Fig. 2. This arrangement prevents the cooling of the metal in the crucible, and furthermore the pot and the furnace remain at a high temperature, thereby greatly reducing the time required for making the next heat. The furnace body is of steel plate construction, and by the use of the double covers, practically no heat is permitted to escape. It is built for the use of either gas or oil as fuel, and the special burner with which it is equipped atomizes the oil, and the air supply is so regulated that ideal combustion is insured. When the furnace is in operation there is no discharge of smoke, nor can any odor from the burning oil be detected, indicating perfect combustion.

A novel oil-handling system for supplying fuel to the furnace at any desired temperature or pressure, automatic in operation, has been developed by this concern. The main supply of oil is stored in a tank outside of the building in which the furnace is located, so that the only oil in the circulating system in the foundry is the small quantity contained in the suction and discharge pipe, which is from ¾ to 1 inch in diameter. A relief valve is also provided by means of which the oil returns automatically to the tank when the furnace is not in operation. The entire oil-burning device is controlled by two valves, one for the oil and the other for the air blast.

When used for melting gray iron, the output averages about 400 pounds per heat, and four heats can readily be taken off in a day. The results thus far obtained with iron have been gratifying. Owing to the fact that the iron does not come in contact with coke or other melting medium, as in the cupola, there is no increase in the sulphur content and the other metalloids, such as manganese, silicon and carbon are under absolute control. For this reason, clean iron is insured and no change occurs in the mixture as a result of the melting operation, owing to the low percentage of oxidation. Automobile engine cylinders cast from iron melted in this furnace, when machined, were absolutely free from dirt, blow holes and other defects. Furthermore, the metal is sufficiently fluid for pouring castings of intricate design and thin wall section. When melting gray iron, the oil consumption is only five gallons per 100 pounds of metal.

Melting copper, brass or bronze, the furnace has a capacity of from six to seven, 400-pound heats per day. The oil consumption is only two gallons per 100 pounds of metal melted. The oxidation of the non-ferrous metals melted in this furnace is also very low, and on bronze is less than 1 per cent, while on yellow brass it is claimed to be less than 2 per cent. The furnace is also especially well adapted for melting borings, turnings, etc., as the metal melts first in the bottom of the crucible, thereby insuring a low melting loss.

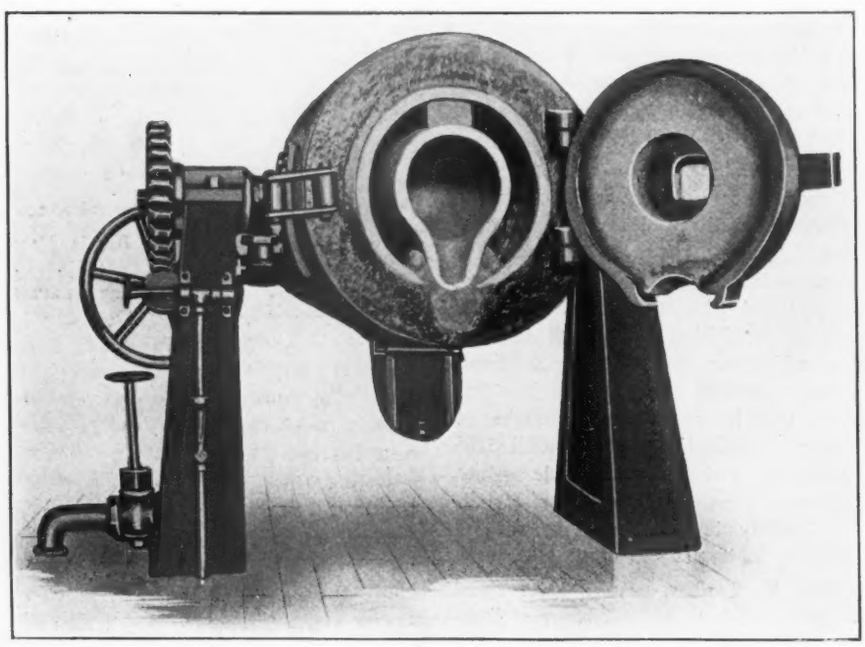


FIG. 1—TILTING CRUCIBLE FURNACE WITH COVER SWUNG BACK SHOWING CRUCIBLE

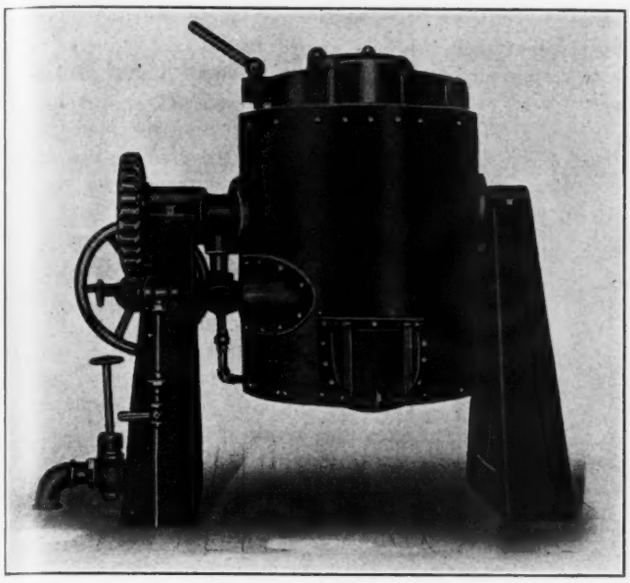


FIG. 2—TILTING CRUCIBLE FURNACE IN MELTING POSITION

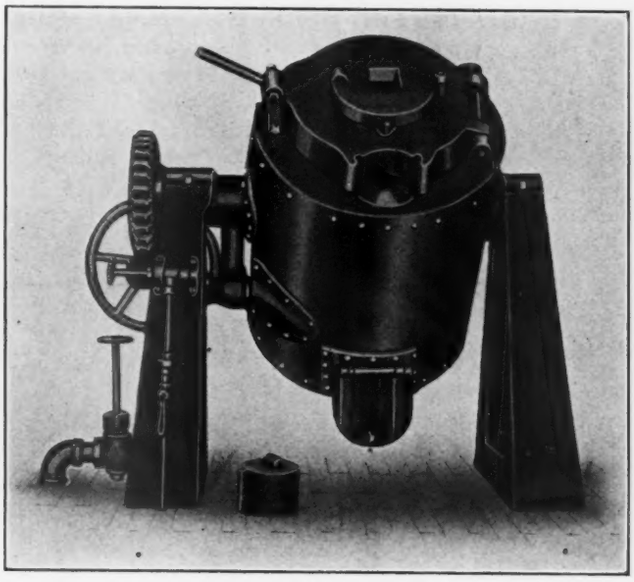


FIG. 3—TILTING CRUCIBLE FURNACE IN POURING POSITION

CONTINUOUS ANNEALING AND HARDENING FURNACE.

The Rockwell Furnace Co., 26 Cortlandt street, New York city, has recently made a number of improvements on its internally-fired, rotary annealing and hardening furnace, which gives greater flexibility in the range of work that can be handled, and also adds to its durability. Heretofore this furnace was built with a brick lining, which formed deep helical channels with separating spiral walls for feeding the material forward. This arrangement proved satisfactory for light smooth pieces, such as lock washers, balls, etc., and is still spirally lined for this class of work, but was found unsuited for long pieces such as bolts, rivets, etc., and irregular shaped steel punchings, forgings and castings.

In the present type of furnace, shown in the accompanying illustrations, for smooth or round work, the rotating cylinder or drum is lined with a standard hard refractory brick, with a smooth internal surface. The furnace is mounted in such a way that its axis may be tilted at an angle giving the revolving hearth an incline with the discharge end lower than the entrance or feed end. This gradual incline causes the material to feed forward, and by means of a hand wheel, the degree of pitch may be adjusted so as to regulate the progression of the material through the furnace and consequently the time of heating.

The advantages of this method of automatic continuous heating are many. The material is charged in the hopper in bulk at the exhaust end of the furnace and is fed automatically into the chamber, the material coming in contact continually with the heated surface of the chamber, which is revolving, thereby absorbing the heat from the lining as well as from the heated gases. In stationary furnaces, the heat from the sides and roof is not utilized, as the material remains in a fixed position. Tests of material heated and hardened in an internally-fired, rotary furnace, at the rate of 2,000 pounds per hour, have failed to show the slightest variation. As a pyrometer is used to insure a uniform temperature, and with the chamber tilted to feed at the proper speed, the product must be absolutely uniform.

In operation, the pieces are fed continually into one end of the cylinder. The furnace is fired internally from the opposite end, with the zone of highest temperature at the discharge end. The cylinder revolves slowly, one to four revolutions per minute, and owing to the slight incline of the furnace, the pieces treated fall slightly forward at each revolution, gradually progressing toward the discharge end, where they fall into a receptacle or bath after reaching the desired temperature.

To prevent oxidation, the end of the discharge spout may be carried beneath the level of the bath, thereby sealing it and excluding the air. By the use of this furnace, wear on the lining is reduced to a minimum and it does not require removal until the greater portion of the brick has been worn away. For certain classes of work, such as balls, nuts and uniform shapes, the helical or worm type is used, and this furnace may be lined either way as preferred, but if a smooth lining can be used the cost is reduced and greater life is insured. Oil or gas may be used as fuel. The furnaces are built to meet a wide range of requirements, and in sizes up to a capacity of 2,000 pounds of material per hour.

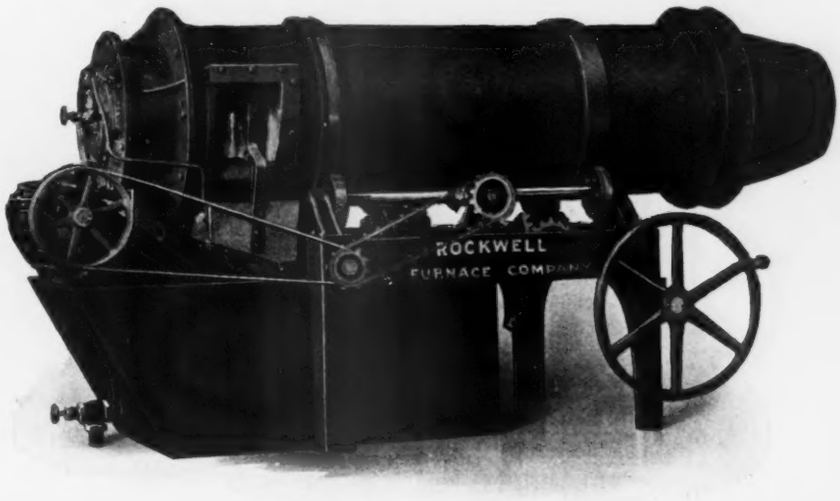


FIG. 1—ADJUSTABLE AUTOMATIC ANNEALING AND HARDENING FURNACE

A STUDY OF THE OPEN-HEARTH.

The Harbison-Walker Refractories Co., Pittsburg, in a well printed, leather bound volume, entitled "A Study of the Open Hearth," containing 91 pages, presents in concise form the principles involved in the manufacture of open-hearth steel. Detailed descriptions of the construction and operation of these furnaces are given in simple language that can be readily understood by one familiar with no more than the most elementary principles of chemistry and metallurgy. This study of open-hearth furnaces was originally compiled by this concern for the use of its operating department, inasmuch as it was realized that by only a full understanding of all of the conditions encountered in open-hearth practice, can refractory materials be so manufactured as to maintain the highest standard for such work.

Details of the construction of both basic and acid furnaces are spread over no less than 41 pages. Practical instructions are given for building the hearths and bottoms, front and back walls, bulk heads, ports, regenerators, etc., while the various materials for the bottoms—acid, neutral and basic—are discussed at length. One entire chapter is devoted to fuels, including natural, artificial and producer gas and oil.

Simple methods of estimating charges for both basic and acid open-hearth furnaces are presented, and these should prove of the utmost value not only to shop superintendents, but melters as well. The elimination of impurities during and after melting is explained in detail, and other subjects treated include recarburization, melting, method of charging, removal of slag, etc. The special processes such as the Talbot, Monell, Bertrand-Thiel and the duplex are briefly described.

This book is unique in that it contains no advertising matter, and is the first of a series that will be published from time to time by this concern, and will be followed by others on blast furnaces and hot blast stoves, heating and puddling furnaces, etc.

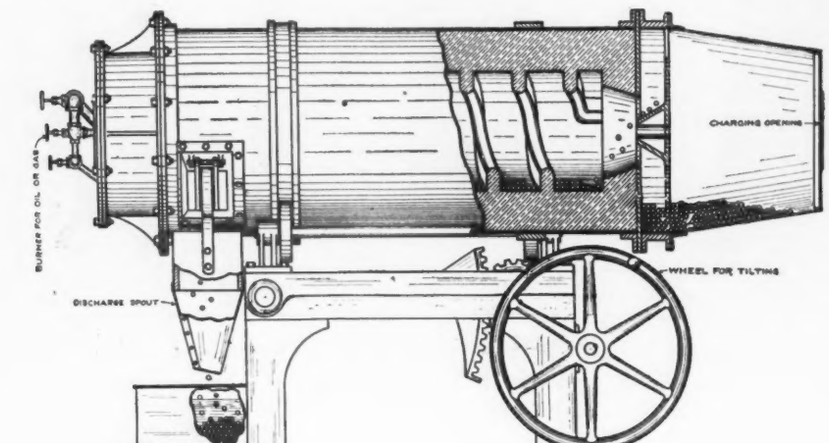


FIG. 2—ADJUSTABLE INCLINED TYPE WITH HELICAL LINING

CONSERVATION OF NON-FERROUS METALS.

The extent to which old metals are recovered and re-used in the United States has heretofore been more or less a matter of conjecture, particularly outside of the industries immediately concerned. A similar lack of information has existed as to the extent to which economies in the use of metals are practiced by their recovery from skimmings, drosses, by-products, etc. In Europe incomplete statistics of such production of metals are gathered, and for 1907, the United States geological survey made a systematic attempt to ascertain the production of copper, lead, zinc and tin so recovered in this country. To distinguish them from the so-called primary metals, which have been produced directly from the ore, these metals are called secondary. A part of these secondary metals is produced and sold as raw material, but a very considerable portion is turned out as alloys, such as brass, bronze, babbitt and type metals. The following table gives the result obtained by a canvass of the industry:

PRODUCTION OF SECONDARY METALS IN THE UNITED STATES IN 1907.

	Short tons.	Approximate value.
Secondary copper as raw metal and in alloys.....	30 240	$11,188,800
Secondary lead	9,990	2,702,788
Recovered lead in alloys..	15,508	.....
Secondary spelter	18,841	.....
Recovered zinc in alloys...	1,417	2,390,444
Secondary tin	93	914,404
Recovered tin in alloys....	1,569	.....
Total		$17,196 436

PITTSBURG FOUNDRYMEN'S ASSOCIATION.

At the monthly meeting of the Pittsburg Foundrymen's Association, held at the Fort Pitt Hotel, Pittsburg, Sept. 13, Dr. Jos. A. Holmes, expert in charge of the Arsenal Testing Station, one of the departments of the Technological Branch of the United States Geological Survey, made brief reference to the work his department is carrying on at the station, including the testing of coal, coke, etc. Congressman James Francis Burke referred eloquently to the importance of the upbuilding of a merchant marine and the possibilities in the Far East and South American republics for marketing a much larger part of the products made in the United States.

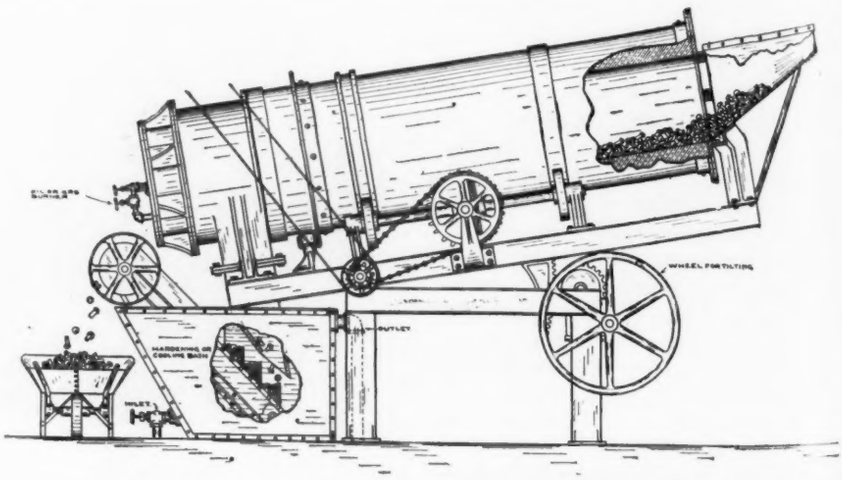
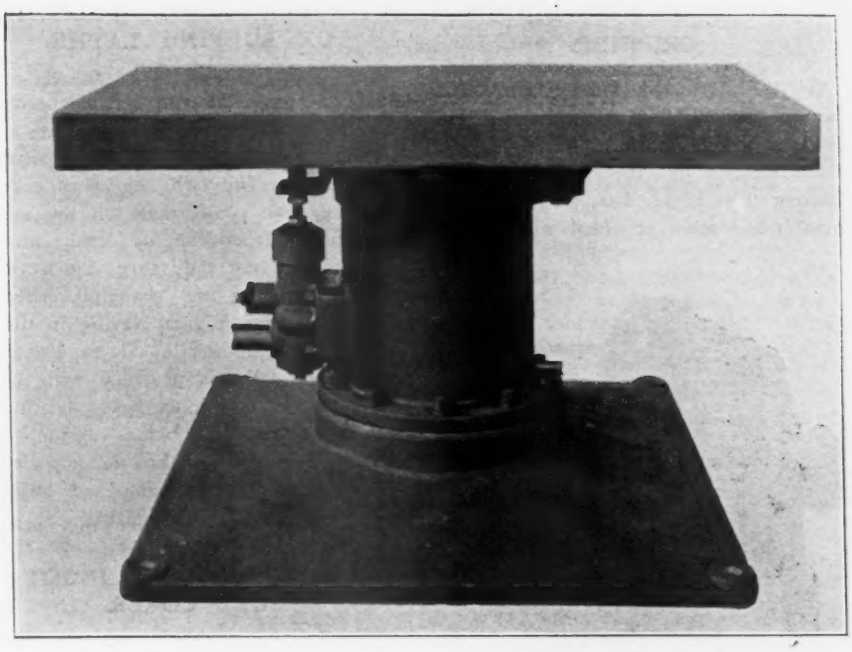


FIG. 3—ADJUSTABLE INCLINED TYPE WITH PLAIN LINING

THE OSBORN PLAIN JOLT MOLDING MACHINE.

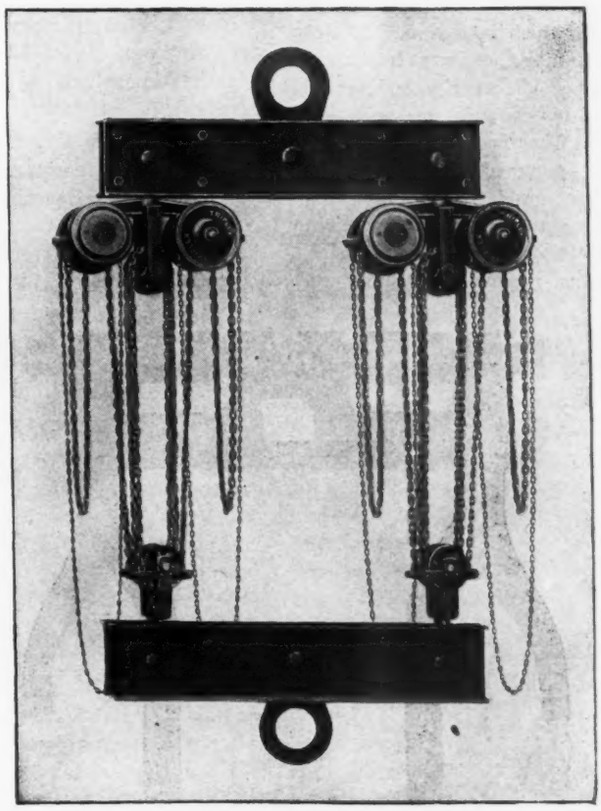
The Osborn Mfg. Co., Cleveland, is now building a line of plain jolt molding machines, illustrated in the accompanying illustration. These are so constructed that a variation in the length of stroke may be obtained from 3 16 to 1½ inches. This is controlled by a traveling valve. This variation in the length of the stroke will prove of great advantage in foundries molding a varied line of work, and where there is a variation of the air pressure. The cylinders of these machines are ample in diameter, insuring stability throughout the molding operation and accuracy of stroke. It is claimed that each machine will be found to have a lifting capacity greatly in excess of its rating. The machine is economical in the consumption of air, which is accomplished by the use of an ingenious blocking device in the air chamber. These molding machines are built in various sizes having the following lifting capacities: 1,000, 1,500, 2,000, 5,000, 10,000, 15,000, and 20,000 pounds.



OSBORN PLAIN JOLT MOLDING MACHINE

A 40-TON CHAIN BLOCK.

To meet the demand of engineers for a dependable hand hoist to handle extremely heavy loads where the installation of an electrical crane or a powerful steam hoist is not desirable, the Yale & Towne Mfg. Co., New York city, has developed the 40-ton triplex chain block shown in the accompanying illustration. Although the ordinary mechanical man is accustomed to think of chain blocks of the smaller capacities only, ranging from the one-eighth differential up to possibly 5-ton blocks, the larger sizes under certain conditions are just as available as the differential is for light loads. In fact, this company for several years has made its triplex blocks up to 20 tons capacity.



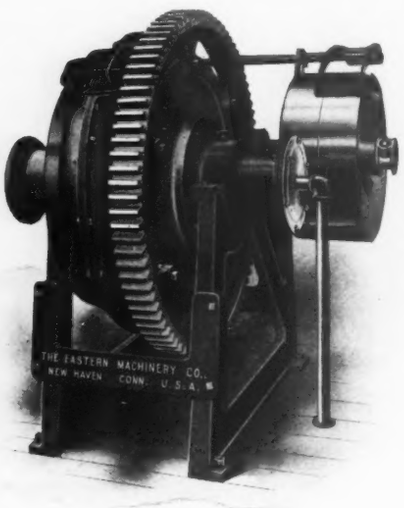
YALE & TOWNE 40-TON CHAIN BLOCK

The 40-ton triplex illustrated is composed of two 20-ton units with equalizing bars at top and bottom. This provides for single point suspension and for a single point for attachment of load. The equalizing bars are made of two channels placed back to back with separators. Provision is made for the swiveling of each unit at top and bottom. The clevises or points of attachment enable the user to easily put the hoist in place wherever used and also afford a convenient point for the attachment of the load.

It will find its greatest fields of usefulness in wrecking work (especially marine); in manufacturing plants; at mines and quarries and in building operations, and generally for loading and unloading. It may be installed over railroad tracks on a properly guyed temporary or permanent trestle. Lateral motion may be secured by one or more trolleys running on a large I-beam. It is available for handling heavy ordnance, etc., where head room, cost, infrequency of lift, or other conditions do not permit the use of power cranes of sufficient capacity. The hand chains are arranged to permit two, four or eight men to work effectively. Where the load is larger than 40 tons it is generally of sufficient size to permit two of these hoists to be worked together, giving a capacity of 80 tons.

IMPROVED HILL CINDER CRUSHER.

The Eastern Machinery Co., New Haven, Conn., which recently purchased the patents and business of A. M. Hill, manufacturer of the cinder crusher bearing his name, has placed on the market a crusher provided with a small barrel for use in brass foundries having a limited amount of cinders to wash. As shown in the accompanying illustration, the crusher has been equipped with tight and loose pulleys, and the driving gear has been placed at the side, instead of on the periphery of the machine. It is also equipped with an improved dumping arrangement and water inlet. The crusher has been constructed on the lines of the larger machine and will do the same class of work as the larger crusher, with the exception that the output of washings is less. When washing brass foundry ashes, they are placed in the crusher, which is revolved, and a slow stream of water is permitted to flow through the barrel. The ashes are crushed by a heavy ball. The coal and cinder, after being crushed and separated from the metal, are washed away, while the recovered metal is left in the barrel. This small crusher will prove an excellent addition to the equipment of a small brass foundry, as it consumes very little power and will enable the foundryman to wash his foundry ashes instead of disposing of them as is frequently done. The plant of the Eastern Machinery Co. is well equipped for the manufacture of these mills, and the larger type is adapted for use in brass foundries where a large amount of cinders is separated and the metal reclaimed.



IMPROVED HILL CINDER CRUSHER

A DOUBLE SPINDLE POLISHING OR BUFFING LATHE.

A double spindle polishing or buffing lathe provided with two independent spindles, built by the Osborn Mfg. Co., Cleveland, is shown in the accompanying illustration. The two legs permit two men to work comfortably on the same machine independent of each other. This feature not only saves much time when operators are changing wheels, but also effects a great saving in driving belts amounting to 75 to 100 per cent. The lathe is provided with 1½-inch spindles and long, heavy bearings, and it is also otherwise substantially constructed. This lathe is especially well adapted for polishing and buffing large work, as in stove plants, etc.

MACHINE-MOLDED INGOT MOLD CORES.

The following details on the production of ingot mold cores on a jolt ramming molding machine, are given in *The American Machinist*, by E. H. Mumford, Philadelphia:

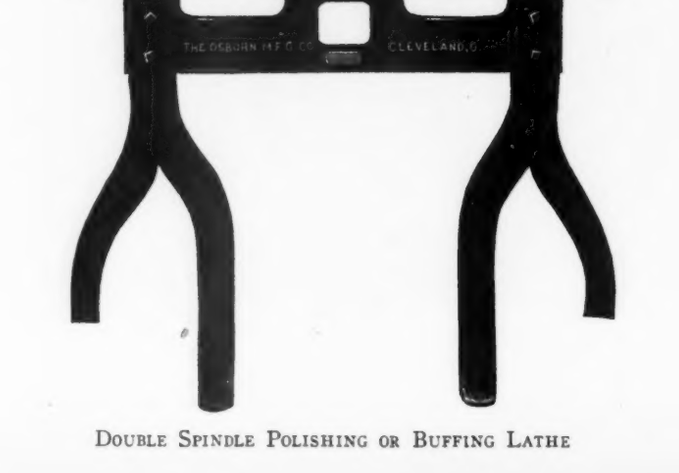
Something less than a year ago, when designing and furnishing molding machines for making molds for steel ingots, an expert of one of our largest steel works remarked that while the machines we were offering for making the outside of molds were satisfactory, it was the inside of the mold, the part which shaped the liquid steel into the ingot for rolling, that most concerned them. This led, last December, to an experiment in which one of our 10-inch jolt ramming machines was loaded to more than twice its capacity and served with air at 140 pounds pressure per square inch. The first core was successfully jolt rammed on this for a standard ingot mold which, including the print, measured 7 feet in height and 31½ x 28½ inches at its base. This core was rammed 82 blows on the small machine. Immediately after this a 16-inch machine of proper capacity for this work was ordered, and since May 30 last, it has been running without intermission and producing ingot mold cores of the above dimensions with two men at the rate of four cores an hour, whereas, previously, it had required five men to make 16 cores a day.

The important fact in this is that the cores produced, being rammed with absolute uniformity throughout their whole length, produced ingot molds with straight internal surfaces that were free from the waviness experienced from the necessary irregularities in ramming by hand, where the sand channel between the core barrel and the core box are as deep, narrow and obscure as in this work. It has yet to be learned how much is to be gained in the durability of the ingot molds or in the rolling operations on ingots that are smoother on their surfaces, owing to their being stripped from straighter molds than have been possible where the ingot mold cores have been hand rammed as heretofore. The works, however, in which machine molding methods are being adopted for the complete production of ingot molds anticipate great advantage in these directions.

TRADE NOTES.

The Macphail Flask & Machine Co. is now located in new quarters at Fort Madison, Ia., and is prepared to make immediate shipment of its extensive line of flasks.

G. Haarmann & Co., Holyoke, Mass., successor to G. Haarmann & Son, manufacturers of the Haarmann core oven, have built a new factory and have otherwise greatly increased their manufacturing facilities. This concern now



DOUBLE SPINDLE POLISHING OR BUFFING LATHE

consists of G. Haarmann and F. W. Wagner.

The Foundry Engineering & Inspection Bureau has been organized at Springfield, Mass., and offices have been established at 952 State street. The foundry engineering department will be devoted to the solving of problems in the shops of its clients. The inspection department was created to fill the requirements of purchasers of material in large quantities, such as cast iron pipe, valves, hydrants, pumps, machinery, etc.

The business of the Jonathan Bartley Crucible Co., Trenton, N. J., has increased to such an extent that it will be necessary to erect another kiln, and build an extension to the plant. This concern has been in business only one year and has made satisfactory progress.

The Herman Pneumatic Tool Co., 1104 Union Bank building, Pittsburg, with works at Zelienople, Pa., devoted to the manufacture of jar ramming molding machines, has recently increased its capacity by the addition of a power plant 40 x 60 feet, and an extension to the machine shop of the same size. During the last six months this concern has built some very large jar ramming molding machines which have been installed in three of the plants operated by the United Engineering & Foundry Co., Pittsburg; William Tod & Co., Youngstown, O.; Buckeye Engine Co., Salem, O.; Modern Foundry Co., Oakley, O., and the Otis Steel Co., Cleveland. The plant is now being operated double turn.

A 12-page booklet of envelope size has been issued by the Jos. Dixon Crucible Co., Jersey City, N. J., describing its line of foundry facings. Some general information is briefly given on the proper use of facings, values of different kinds, working conditions met in foundry practice, etc. A price list of the various graphite products, such as facings, core washes, etc., is also included.

The first of a series of articles on "Foundry Troubles" was published in the September issue of the *Obermayer Bulletin*, published by the S. Obermayer Co., Cincinnati. These articles are being written by R. H. McDowell, who has had a wide experience in foundry work, and will cover difficulties resulting from hard iron, melting losses, etc.

The J. D. Smith Foundry Supply Co., Cleveland, reports numerous core oven contracts and installations. The complete core oven equipment has just been furnished for the United States Aluminum Co., New Kensington, Pa.; Buick Motor Co., Flint, Mich.; Allyne Brass Foundry Co., Peerless Motor Car Co., Standard Brass Foundry Co., and the National Bronze & Aluminum Co., Cleveland. Core ovens for the Pennsylvania Steel Co., Steelton, Pa., are being installed and work has been commenced on a large battery of ovens for the Falk Co., Milwaukee; the M. L. Oberdorfer Brass Co., and the Toledo Motor Car Co., both of Toledo, as well as the United States McAdamite Metal Co., Brooklyn.

The instruction book published by the Smooth-On Mfg. Co., Jersey City, N. J., is now in its eighth edition. This book is well illustrated and shows numerous applications of Smooth-On cements. These cements are used for repairing leaks or breaks in castings, for removing blemishes such as blowholes and other defects.

Hutton H. Haley has taken over the entire business of the O. V. Dodge Jr. Co., Dwight building, Kansas City, western representatives of the J. D. Smith Foundry Supply Co., Cleveland.

Oscar E. Perrigo, consulting engineer 6 Beacon street, Boston, is sending to the foundry trade a 4-page folder calling attention to the need of adopting systematic methods in machine shops, foundries and manufacturing plants.

The warehouse of the S. Obermayer Co., Cincinnati, was slightly damaged by fire Saturday, Sept. 11, but no damage was done to the various manufacturing departments. This fire will cause no interruption in the business of this concern, and orders will be filled with the usual promptness.

PRACTICAL SHOP INSTRUCTION.

A student of Sibley College, Cornell University, recently inquired how much credit he would obtain for shop work done during the vacation season, and was advised that it was the practice to give one hour's credit for every two hours devoted to actual work in a shop or foundry approved by the faculty. Inquiring whether the plant of the Yale & Towne Mfg. Co., Stamford, Conn., would fit this description, he was informed that double credit would be given for any time spent in these works, as in the opinion of the faculty it was the full equivalent to the instruction given at the college.

TRADE PUBLICATIONS.

GRATES.—Catalog B, published by Washburn & Granger, 120 Liberty street, New York City, contains illustrations and descriptions of the Dean dumping, shaking and stationary grates.

POWER TRANSMISSION MACHINERY.—The Hill Clutch Co., Cleveland, has issued a 12-page booklet describing its line of pulleys, sheaves, friction clutches, drop hangers, etc., as well as turned steel shafting especially prepared for transmission purposes.

GRINDING WHEELS.—The Norton Co., Worcester, Mass., manufacturer of Alundum grinding wheels, grinding machinery, etc., is sending to the trade a booklet entitled "Facts Worth Knowing About Grinding Wheels". Their method of manufacture is briefly referred to, and rules are included for obtaining surface speeds, calculating speeds and diameters of pulleys, etc.

RECORDING THERMOMETERS.—Bulletin No. 111, published by the Bristol Co., Waterbury, Conn., describes Class II recording thermometers especially adapted for feed water temperatures. Record charts reproduced strikingly show that a far greater uniformity of operation can be secured by the use of these recording thermometers than when the power plant is not thus equipped.

PORTABLE DRILLS, REAMERS AND GRINDERS.—The Peerless line of portable electric drills, reamers and grinders are described and illustrated in a 42-page catalog published by the S. Obermayer Co., Cincinnati. A portable electric chipping hammer is shown which is adapted for foundry and machine shop use, as well as breast drills, portable reamers, bench grinders, buffers, etc.

INDUSTRIAL RAILWAYS.—The Ernst Wiener Co., 50 Church street, New York City, in catalog No. 200, containing 130 pages, describes and illustrates its line of industrial and portable railways for use in foundries, machine shops, etc. Steel dump cars of all types are shown, as well as charging barrels and skip cars. A line of buggy ladles is also illustrated, as well as flat and hand cars of all types.

ANNEALING AND HARDENING FURNACES.—Furnaces for annealing and hardening, built by the W. S. Rockwell Co., 50 Church street, New York City, are illustrated and described in a 4-page pamphlet recently issued by this concern. These furnaces are suitable for a large volume of small work comprising the annealing, hardening tempering or case hardening of tools, dies, punches, springs, machine parts, etc., which require great uniformity of temperature.

CRUCIBLE FURNACES.—Natural draft crucible furnaces, built by the J. D. Smith Foundry Supply Co., Cleveland, O., are described in a 14-page catalog recently issued by this concern. Numerous views are included showing various installations and a list of users is also given. In a 4-page pamphlet published by this concern, the Cleveland squeezer is described, while another pamphlet is devoted to the Cleveland Jr. core oven, which is semi-portable, and is provided with rolling drawers. It can be heated by either coke, coal, oil or gas.

FOUNDRY TRAMRAILS.—The J. W. Paxson Co., Philadelphia, manufacturer of foundry supplies, in bulletin No. 120 illustrates and describes the Moyer tramrail for foundry use. Views are given of this overhead system adapted for charging floor service, handling metal, carrying cores to and from the stock room and distributing the same on the foundry floors, for the delivery of molding sand to the molding floors, conveying finished castings, etc. The bulletin is handsomely illustrated and contains much valuable information on overhead conveying machinery for foundry use.

FLEXIBLE TRANSMISSION.—The Coates unit link flexible shafting, manufactured by the Coates Clipper Mfg. Co., Worcester, Mass., is described in bulletin No. 22, containing 56 pages, issued by this concern. The wide application of this flexible transmission is shown

by numerous illustrations. It is used for buffing, drilling, polishing, grinding metals, and glass, clipping, painting, aluminum roughing, etc. This flexible shafting is well adapted for grinding castings, and the electric stove polishing outfit is described in detail. An electric hammer operated by a flexible shaft is one of the latest developments of this transmission, and it is claimed that it strikes a blow equal to that of a pneumatic hammer.

BRASS FOUNDRY ALLOYS.—The United States Alloys Co., Baltimore, Md., manufacturer of metals, alloys and fluxes, is sending to the trade a 6-page folder describing fluxes for brass foundry use. Flux No. 1 cleans the metal bath and converts the impurities into a fusible slag which rises to the surface and can easily be skimmed off. No. 2 flux has essentially the same action as No. 1, but is somewhat milder, and is preferred by some brass founders as it can be used in somewhat larger quantities, approximately one half pound per 100 pounds of metal. No. 1 flux is neutral in its action, whereas No. 2 is slightly acid. This concern also manufactures manganese - copper, silicon-copper, manganese-silicon-copper, ferro-silicon, ferro-manganese, as well as other deoxidizers and alloys for brass foundry use.

GENERAL INDUSTRIAL NOTES

The Eberton Brass Foundry Co. has been organized at York, Pa., by John H. Cochrane, formerly of the Pennsylvania Foundry Co. of that city, and Henry Rabe. This concern will engage in the manufacture of brass, bronze and aluminum castings of all kinds.

The Ohio Crucible Steel Co., Cleveland, is now operating a steel foundry for the production of special machinery and automobile castings. Two furnaces having a capacity of 10 crucibles each have been installed, and other extensions are now being contemplated.

The Niagara Machine & Tool Works, Buffalo, has purchased a site of about seven acres adjoining the New York Central Belt Line, upon which a number of buildings will be erected, equipped to manufacture machinery for working sheet metals, including presses, squaring and rotary shears, etc.

The Hildreth Mfg. Co., Lansing, Mich., recently completed a new machine shop and office building 225 x 55 feet, two stories high, with a testing room 18 x 40 feet, one story high. A new boiler and engine room 25 x 40 feet is also being built and air compressors are being installed. A plating department has also been added and a large core oven will soon be installed in the foundry.

The Berkshire Mfg. Co., North Adams, Mass., has purchased the Brooklyn foundry located at that place, and will continue the manufacture of brass and iron castings.

The foundry operated by the Guthrie School & Office Furniture Co., Guthrie, Okla., recently organized, is engaged in the manufacture of castings for school desks.

The L. L. Jackson Foundry, Ashtabula, O., has been purchased by the Barber Mfg. Co. of that place, and the equipment will be removed to the Barber plant.

The branch foundry of the Pennslyvania Steel Co., York, Pa., located at Glenville, Pa., has been removed to York.

The Inland Steel Casting Co., Terre Haute, Ind., has just completed a steel foundry, 75 x 350 feet, provided with a core room, 40 x 65 feet. The shop is equipped for the production of crucible steel castings.

James W. Carr, iron and brass founder, Richmond, Va., is building a two story brick foundry at an estimated cost of $7,000. No additional machinery will be required as the new building is being erected to provide additional floor space.

The Cook-Lewis Foundry Co., Winsted Salem, N. C., has completed an addition to its foundry, 40 feet square. Another five-ton cupola has also been installed.

The Rogers Silver Plate Co., Danbury, Conn., will erect a two-story brick building, 40 x 90 feet, to be used for the plating and burnishing departments.

The Star Foundry Co., formerly located at Riverside, near Seattle, Wash., has leased the plant formerly occupied by the Phoenix Artistic Bronze & Iron Foundry at Youngstown, near Seattle. This concern makes a specialty of brass and bronze castings.

The new plant of the Frontier Iron Works, Buffalo, was recently placed in operation. The foundry is 220 x 90 feet, and the pattern shop and storehouse, 125 x 50 feet.

A. Weiskittel & Son Co., Baltimore, Md., manufacturer of soil pipe and plumbers' supplies, has recently completed a new iron foundry at its Highlandtown plant, 175 x 380 feet.

The Globe Metal & Iron Co., Columbus, O., has built a new foundry, the equipment including a Buffalo blower, 48-inch cupola, etc., having been purchased from the Central Foundry Supply Co., Columbus, O.

The Jeffrey Mfg. Co., Columbus, O., has doubled the floor space of its foundry by the erection of an addition, 75 x 203 feet. A large numoer of molding machines will be installed, of various makes to meet the requirements of the various kinds of castings made by this concern. In addition to the regular shop for the manufacture of wood and metal patterns, another department has been added for the production of patterns for use on molding machines only. The daily output of light castings will be about 20 tons and the entire foundry output is placed at 50 tons.

New Construction.

The Best Foundry Co., Bedford, O., the foundry department of the American Stove Co., will practically double the size of its plant by the erection of an addition 200 feet long. Specifications for the necessary equipment are now being prepared and contracts will be awarded for the same early in October. This will include a cupola, blower, machinery for hoisting material to the charging floor and approximately 25 molding machines. Henry Molder is superintendent of the foundry and the Interstate Engineering Co. is preparing the plans.

The Pacific Metal Works, Portland, Ore., is erecting a foundry, 30 x 70 feet, and a warehouse, 100 feet square. The Oregon Brass Works will occupy the premises now held by the Pacific Metal Works as soon as the latter moves to its new quarters.

The National Steel Casting Co., Montpelier, Ind., is building an addition to its foundry, 120 feet long.

The Hancock Mfg. Co., Charlotte, Mich., will erect a new brass foundry, 169 x 162 feet. Plans have been prepared by Huehl & Schmid, architects, Chicago.

The Scullin-Gallagher Iron & Steel Co., St. Louis, will erect a one-story pattern shop at a cost of about $10,000.

The Malleable Iron Fittings Co., Branford, Conn., will erect a new foundry, 200 x 135 feet.

The Kingsford Foundry & Machine Co., Oswego, N. Y., will erect an addition to its foundry and machine shop, 75 x 125 feet.

The Holyoke Motor Foundry Co. will erect a new plant, 80 feet square, of steel and concrete construction. The General Engineering Co., New York, is preparing the plans.

The Wichita Mfg. Co., Wichita, Kans., has begun the erection of a foundry, 113 x 60 feet.

The Aetna Foundry & Machine Co., Warren, O., will erect a pattern shop, 40 x 50 feet, three stories high.

The Brush Runabout Co., Detroit, manufacturer of automobiles, engines and automobile parts, is building a new plant on a site of 19 acres, recently acquired. This will include an experimental and repair building, 64 x 150 feet; machine shop, 150 x 337 feet; brass foundry, 45 x 170 feet; paint shop, 150 x 208 feet; as well as a blacksmith shop, case hardening and tempering building, motor and chassis testing building, power house, enameling shop, pattern vault and office building.

E. E. Brown & Co., Philadelphia, will erect a new foundry, 80 x 112 feet, one and two stories high, of steel and reinforced concrete construction.

The Mohawk Foundry Co., Schenectady, N. Y., will erect a new plant in Scotia, at Vlay road and the Boston & Maine railroad. It will consist of two buildings, machine shop, 30 x 40 feet, and a foundry, 50 x 100 feet. Two cupolas will be installed and the core shop will be 12 x 12 feet. This concern was recently incorporated with $25,000 capital by A. F. Shaffer, A. F. Hallbauer and M. V. Hoffman.

The Sivyer Steel Casting Co., Milwaukee, which leased one of the foundry buildings of the Northwestern Malleable Iron Co., will build a large plant on a site between Milwaukee and West Allis.

The Puget Sound Iron & Steel Works, Tacoma, Wash., will erect a new plant, which among other departments will include a foundry, 90 x 126 feet, that will be equipped with a 15-ton traveling crane.

Plans have been prepared for the new plant of the Climax Mfg. Co., which will be removed from Seneca Falls to Schenectady, N. Y. The foundry will be 40 x 146 feet. This concern makes a specialty of the manufacture of plumbers' brass goods.

The Gus Pech Foundry & Mfg. Co., Lemars, Iowa, is building a new shop, 40 x 108 feet, of concrete and steel construction.

The Menough Foundry Co., Wellsville, O., whose plant was recently destroyed by fire, will erect a new foundry, 50 x 40 feet, of brick and concrete construction.

The Seaboard Steel Casting Co., Chester, Pa., will erect an addition to its foundry, 80 x 60 feet.

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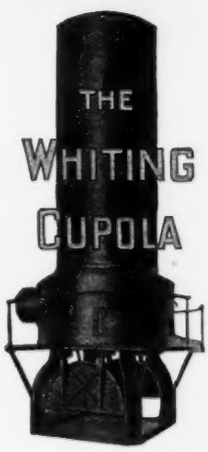

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